MACHINE DESIGN

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made of Carpenter No. 4—the 18-8 typ
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corrosion resistance.

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they could be made just as easily from
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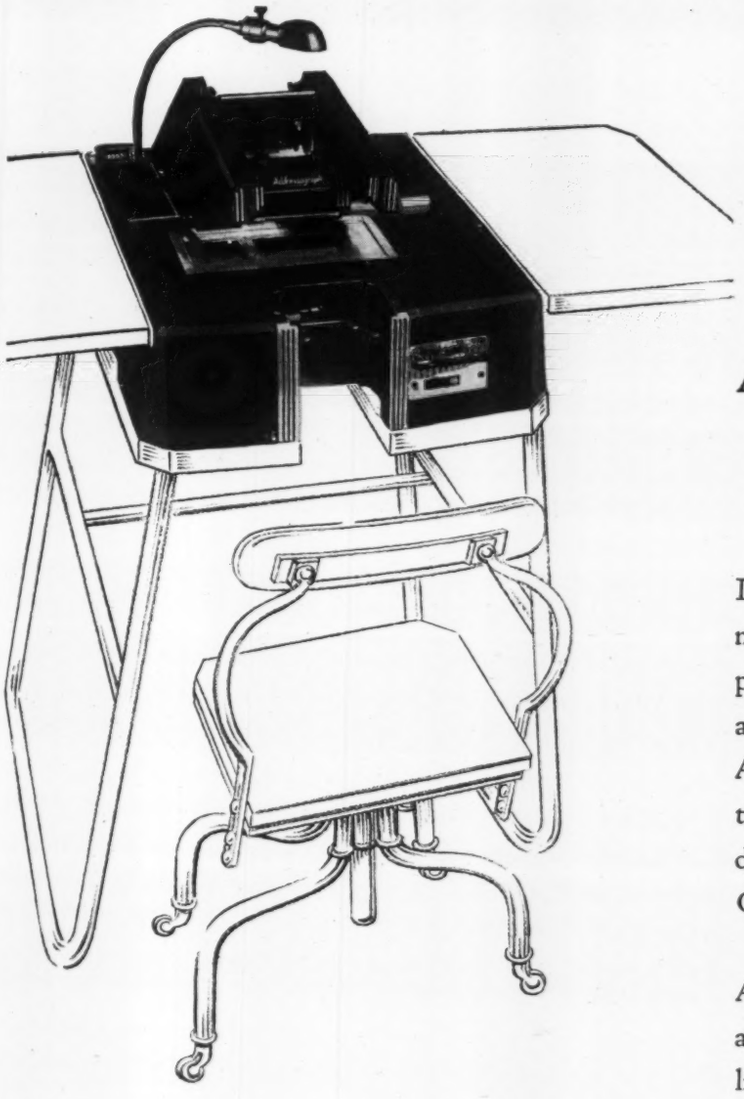

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Topics . . .

DESIGNERS, fortunately, will never admit that anything they have developed, or anything competing designers have developed cannot be improved upon. Diesel power for the railroads arrived with great fanfare—paeans of praise overflowed the country—the layman would be led to believe that the problem was solved for all time. But not so the designer. Although they admitted the advantages of diesel power, and the merit of the advance, designers set out to prove the worth of other forms of power. First, steam engines were modified and improved. Soon GE will complete the construction of a new steam-electric locomotive, another step forward in the transportation picture.

♦ ♦ ♦

This new passenger locomotive will carry a condensing steam turbine generating plant feeding traction motors. Electric power will drive these motors, constructed on the usual electric locomotive design, and the turbine will operate condensers using the same water over and over. Today's locomotives are far ahead of the picturesque Iron Horse, and today we are just getting underway, heading toward even greater achievements.

♦ ♦ ♦

Another field which has registered great advances, and one which will soon demonstrate even more important achievements, is the design of automobile carburetors. When one low-priced car brought out a unit which increased mileage approximately 25 per cent, it was certain that the others in the field would attempt to outdo the first. A reliable report has it that one maker of low-priced automobiles is soon to announce a radical departure in carburation, in which a new spray device is used which is said to assure forty miles to the gallon at conventional horsepowers. Every car owner will be on the sidelines to cheer on the fight and urge the competitors to even greater mileage records.

♦ ♦ ♦

Business conditions are improving at such a tremendous rate that it takes daily reports to keep abreast of the advance. Steel operations, at a time of the year when they could be expected to recede, have risen to a point where one must go back to 1929 for a parallel, with the exception of a few months early in 1930. At the start of September, operations were at the highest point since the end of May, 1930, and exceeded the period from the middle of November, 1929, to the middle of February, 1930. Electrical power production almost weekly sets all-time records, and this index for 1936 is increasing its margin over 1935, the previous banner year. For July, the last month available, the figures showed industrial production as another index demonstrating consistent gains. This figure had increased for the fifth consecutive month.

♦ ♦ ♦

Technical education, responding to the need, has for several years been offering worthwhile courses in design for welding. These courses, totally unknown to the engineer who graduated as recent as eight years ago, are supplemented by commercial courses designed to bring all technical men up to date. Now data on another comparative newcomer in the design picture is being made available to engineers who once did not even consider it. Regular evening courses in a metropolitan New York university will include study of heating, ventilating and air conditioning, and add another talent to the engineer's repertoire.

♦ ♦ ♦

In aircraft design they believe in proving their conclusions. Twelve hundred typewritten pages of engineering calculations were required in computing the strength of the new Lockheed 12. One would think that would be almost enough. Yet the engineers hoisted a completed plane in the air by a crane and loaded it with sand ballast to prove without question the accuracy of their structural computations.

MACHINE DESIGN

By D. M. Fincke

Chief Engineer, Baking Equipment Division, American Machine & Foundry Co.

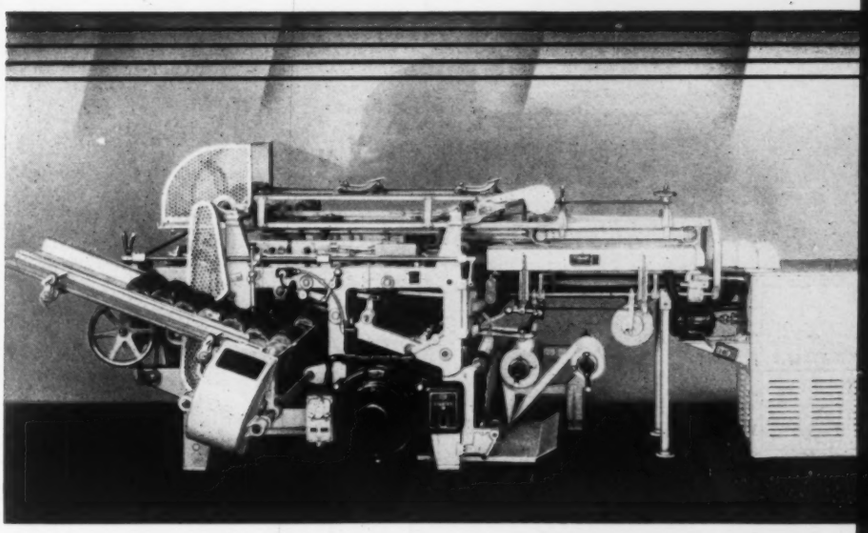


Fig. 1 — Wrapping machine has refrigerated cooling for sealed package ends

Refrigeration Reaches Wrapping Machinery!

BREAD is wrapped commercially by machines using either fully waxed self-sealing paper or one of the newer heat-sealing cellulose papers. Both of these papers require the application of heat to the folded sections of the paper after the package has passed through the folding mechanism so that these folds will be sealed without the necessity of adding an extra adhesive. In the case of the waxed paper wrappers, it is necessary to cool the wax after heat has been applied so that it will, after congealing, form a satisfactory adhesive to hold the folds in place. A new method of accomplishing this, utilizing refrigeration, has been developed in the engineering department of American Machine & Foundry Co., Brooklyn, N. Y., for use in connection with its Standard bread wrapping machine, *Fig.* 1, the device being known as a frigid seal delivery.

The earlier method of cooling the waxed paper folds was to deliver the package from the heated zone into a so-called cooling zone, which consisted of a belt conveyor designed to carry the package and at the same time hold the folds in place until the wax had had an opportunity to congeal. In the case of the Standard bread wrapping machine, this required two side and one bottom delivery belts with a distance of 9 feet between centers. Naturally these belts after continued operation of the machine in high room temperatures, in addition to the heat transmitted to the belts from the packages as they left the heating zone, caused sealing difficulties as the belts got too hot for satisfactory

sealing. A further difficulty was that the wax remaining on the paper had a tendency to be absorbed by the belts which not only caused difficulty due to wax accumulation on the belts, but also did not permit wax to remain on the paper of the package which has a tendency to stiffen the bread package.

Many experiments were conducted using other types of belt deliveries in combination with tanks mounted behind the belts in which water was circulated, cracked ice and also dry ice. It was found, however, that refrigeration below the temperature of 32 degrees Fahr. was most satisfactory. Another object of the refrigerated delivery was to provide a positive

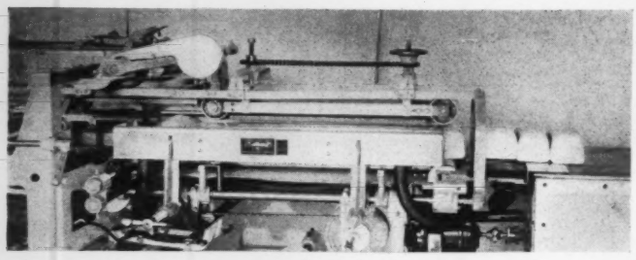


Fig. 2—Two belts convey the packaged loaf through the sealing zone as shown herewith

means of cooling irrespective of weather conditions, different size packages or variations in the speed of the machine. An additional feature is the saving in floor space required. With the belt type of delivery, 9 feet was required whereas with the refrigerated delivery only 38 inches is required for complete sealing of the package.

Experiments were conducted using a direct expansion of the refrigerant and also with a self-contained brine system. A brine system, *Fig.* 2, was finally adopted as it was found to be more practical and reliable. A standard ½-horsepower commercial condensing unit, charged with Freon or methyl chloride, is used and a framework built around it to hold a main brine tank which is installed directly over the condensing unit. This brine tank is made of sheet copper, with all seams made as lock seams and copper welded. No solder is used at any point in the refrigerating assembly. The brine tank is separated from the condensing unit directly underneath it by 4 inches of sheet cork insulation. The sides of the brine tank are insulated with 3 inches of sheet cork and the top lid of the brine tank has 2 inches of sheet cork insulation. The cork is sprayed with a hot tar composition before assembling to prevent moisture being absorbed by the cork. All edges of the cork are bevelled, and the seams filled with hot tar at the time of assembly. The cork is protected on all sides with sheet metal cemented to the cork with hot tar so that the insulation will be fully protected against moisture absorption or against mechanical damage.

In the brine tank is assembled a double row of copper tubing in coil form which is connected directly to the compressor of the condensing unit, and through which the refrigerant is expanded. An automatic expansion valve is used to expand the liquid fully in this copper coil. Inserted in the brine surrounding these coils is a thermostatic bulb for temperature control which is connected in series with the motor circuit driving the compressor. The normal setting of this thermostatic temperature control is to start the condensing unit when the temperature of brine reaches 17 degrees Fahr. and to cut it out when the temperature is reduced to 13 degrees Fahr. This unit is directly connected across the line with proper fuses so that it maintains a constant supply of cold brine at all times for immediate use when wrapping is started. The removable top of the brine tank becomes the take-off table on which the bread packages accumulate as they leave the sealing zone.

All-Bronze Pumps Employed

The circulating system for the brine consists of an all bronze centrifugal pump with stainless steel shaft directly connected to a 1/6 horsepower 1800 revolutions per minute motor. The pump housing is built into the side of the brine tank so that it is entirely surrounded by the cork insulation to prevent frosting and heat loss at the pump. The packing gland on the shaft lies outside of the cork insulation so that it is readily accessible at all times. Suction of the pump is below the surface of the brine, and the discharge is connected through a tee to two side sealing tanks which come in contact with the ends of the package. These sealing tanks are 38 inches long by 3¾ inches high, and are made of seamless extruded copper tubing having one side convex. The convex side is the one that contacts the bread package so that it will reach into any hollows which are customary on the end of a loaf of bread. The ends of the copper sealing tanks are plugged and copper welded. Inlet and outlet connections are welded directly to the tanks at extremities and mounting blocks are also welded directly to the copper tubing. The discharge from these two side sealing tanks is connected to a bottom sealing tank before the brine is returned to the main brine tank.

In operation, the pump tends to flood the sealing tanks with the cold brine at all times. Six gallons of brine are circulated per minute. The side tanks and the bottom tanks are well insulated with sheet cork and are mounted on rigid supports by means of long Bakelite bushings to reduce heat loss to a minimum. Protective covers house these tanks to prevent me-

(*Concluded on Page* 58)

Scanning the Field . . . FOR IDEAS

SHAFTS NOW "FLOAT" IN RUBBER

EVER widening application of the use of rubber in industry is indicated by a novel type of pillow block now being introduced in connection with antifriction bearing applications to light services such as fans used on household heaters of forced air type, on shafts ranging from 11/16-inch to 1 7/16-inch in diameter.

This new Fafnir pillow block, shown in *Fig.* 1, has the appearance of being of conventional cast iron design. Actually, however, it is of molded rubber, of consistency slightly stiffer than that of a rubber heel. Metal bushings are pressed into the bolt holes in the lugs and the sealed, prelubricated bearing is pressed directly in place in the rubber housing, being followed by a shielding plate, a rubber insulating washer and a thrust collar. Thus the bearing is securely clamped in place. The exterior of the block is treated with lacquer to prevent deterioration in service.

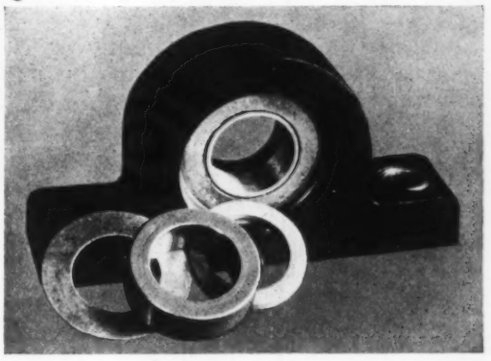


Fig. 1—*Floating power effect is provided by molded rubber pillow block*

The rubber pillow block will twist sufficiently to allow for slight misalignment of the shaft and compensate for endwise expansion. When the shaft is subject to vibration, it also gives a "floating power" effect which eliminates noise and damps the vibration.

ROCKER ELIMINATES GUIDES

POSITIVE straight-line motion of crosshead is obtained without the use of guides in the new Decatur deep well pump, *Fig.* 2. Segmental ends of the divided walking beam rock against the surface of a vertical cover plate on the back of the frame, positive contact being maintained by an interior link between upper end of the rocker and lower end of the cover plate, in conjunction with a heavy compression spring which bears down at the center of the connecting link. This spring is held in place by a rod and cap, the rod being anchored into the cover plate. Relation between walking beam, cover plate, link and spring are apparent in the cut.

Every part of the pump requiring oil is lubri-

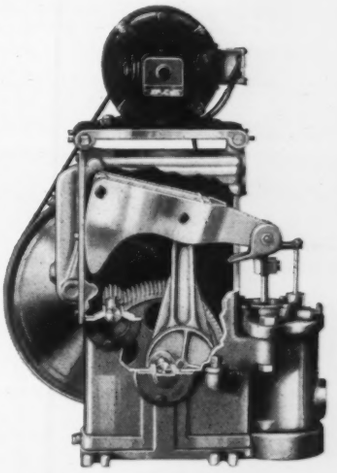


Fig. 2 — *Divided walking beam of this deep well pump has a segmental rocking bearing which gives straight-line motion without the use of guides*

cated automatically by a system in which the gears furnish the pumping action. Oil is delivered through vertical ducts cast in the rear cover plate, to grooves cast in the walking beam. From these grooves the lubricant passes through ducts to each bearing, the surplus being returned to a large reservoir in the bottom of the gearcase.

The compact case which houses gears, bearing, etc. presents a pleasing appearance in addition to offering a means of symmetrically supporting the bearings carrying the various working parts, thus maintaining alignment and avoiding side strains and cramping.

MAGNETIC FLUX INDICATES AMPERAGE

WHEN measuring current carried by feeder lines, leads in motors, etc., several instruments, breaking of circuits and consequent loss of time ordinarily are involved.

To avoid all this, and to permit of readings is cramped places, the Tong Test ammeter has been developed. One of these in use in checking motor load, is shown in *Fig.* 3.

The instrument is of split electromagnet type and operates on the moving iron attraction principle. The magnetic circuit—or "tongs"—consists of two equal packs of iron stampings, one pack rigidly fixed and the other hinged to the diecast frame. The packs are mounted to form an iron core with two gaps—one a butt

Fig. 3—Instrument measures current in a conductor without requiring tapping of the circuit

joint of low reluctance, the other a specially shaped gap of high reluctance in which the "movement" functions.

This movement, embodying a moving iron element, is mounted on sapphire bearings and is sealed in a Bakelite housing. An interesting feature is a pneumatic damping device which is on the principle of the governor vane in the striking mechanism of a clock.

The instrument is held by a Bakelite-shielded handle. By pressing and then releasing the rubber-insulated trigger, the laminated tongs are caused to encircle the conductor, as in *Fig.* 3. Regardless of insulation or armor, the magnetic flux about the conductor assumes the path of least reluctance. Since iron has much higher permeability than air, and much lower reluc-

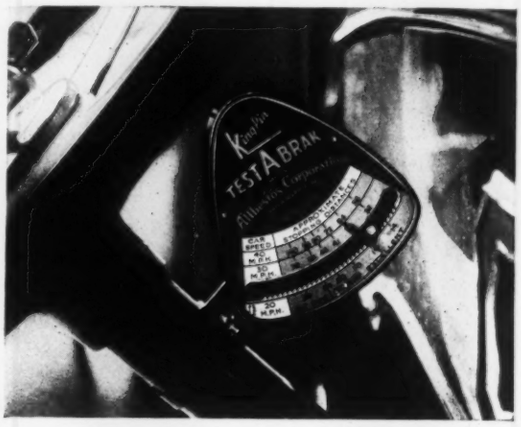


Fig. 4—Amount of throw of a recording pendulum shows condition of automobile brakes

tance, the flux follows the path created by the tongs. The moving iron element thereupon assumes the position of least reluctance, acting against a spring to move the pointer over the ampere scale. This gives a direct reading, accurate within two per cent for alternating current and four per cent for direct, regardless of voltage, wave form or frequency.

Standard instruments are made in various ranges up to 800 amperes, for use on properly insulated lines up to 2300 volts and on bare conductors up to 440 volts. A five-foot impregnated wood handle with insulated operating mechanism is supplied for high voltage work. When bare conductors are in close proximity, rubber insulated tongs are used to prevent short circuiting.

PENDULUM MEASURES DECELERATION

AUTOMOBILE brakes can be tested at any time by the driver through the use of a simple device developed by the Allbestos Corp. This instrument, shown in *Fig.* 4, is clamped to the steering column just below the wheel. It has no mechanical or electrical connection with the mechanism of the car and acts through the inertia of a simple pendulum contained within its own Bakelite case.

To make a test the driver brings the car to a predetermined speed and then brakes to stop in the shortest possible distance. As the car slows down the pendulum keeps moving through its inertia, the amount of its swing being directly related to the initial speed of the car and the speed of its deceleration.

As the pendulum swings forward and upward

it carries an indicator with it. It remains latched at its point of maximum swing as indicated in *Fig.* 4. Through divisions on the instrument scale the driver then can determine directly what condition his brakes are in, a quick stop being indicated by a long swing of the pendulum in relation to the initial speed.

WELDING GUN HAS FREEDOM OF ACTION

ON LARGE work it frequently is desirable to bring the tool to the work rather than the work to the tool. A case in point is a spot welder used on such structures as automobile bodies. Adapting to welding equipment some of the characteristics of portable riveting equipment, the Martin portable spot welding gun, shown in *Fig.* 5, makes it possible for a workman quickly to get at difficult places without moving or turning the work and without having to lift heavy dead weights.

An air piston applies predetermined pressure at the welding spot and this same piston acts to close the control circuit to the welding transformer without use of auxiliary cylinders, air switches, etc. Premature closing or opening of the welding circuit is avoided. To cut down on the weight of the tool, aluminum castings are used wherever possible.

The gun shown is trigger-operated, one spot being welded each time the trigger is pressed. Metal can be "stitched" by a similar tool, in which a switch mounted on the handle is connected to a magnetically-operated air valve which is in turn connected to a timer. This arrangement causes the gun to weld a continuous row of spots, this going on as long as the trigger is held down.

Fig. 5—This spot welding gun is designed to operate in difficult places and over large areas

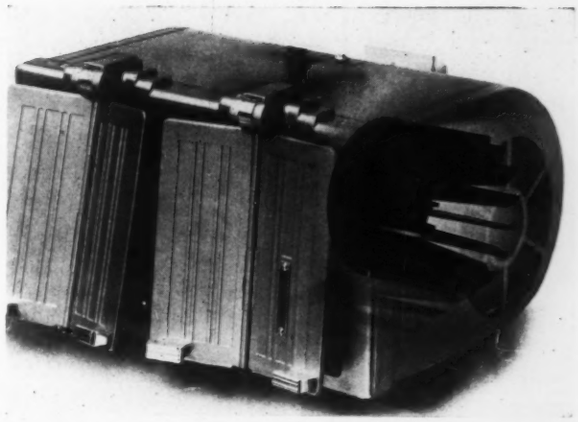


Fig. 6—Molded plastic fans are used in this car heater to attain lightness and exact balance

HEATER HAS MOLDED PLASTIC FANS

USE of plastics for frames, housings, covers and other "static" details of mechanisms manufactured under mass production conditions now is so common as to be considered standard practice. Application of these materials to the actual mechanism is not quite so common and undoubtedly represents a broad field for further development of plastics applications.

An example of the possibilities in this direction is given by the new air stream hot water car heater made by Bishop & Babcock. In this heater, of which a phantom view is shown in *Fig.* 6 fans of molded Durez are located at either side of the drive motor, which is located at the rear center of the housing.

Air is drawn from the sides and expelled through a radiator at the front, the dual impeller arrangement giving a large volume of air with a relatively low speed drive.

CHROME PLATING COMES TO LOCOMOTIVES

SAID to be the largest chrome plated job ever accomplished in a single operation, the heat treated alloy steel main rod shown in *Fig.* 7 is one of a set of two 12-foot main rods and four 9-foot side rods designed and built by Timken. Roller bearing equipped, they are designed for use on high speed passenger locomotives.

An interesting point from the design angle, in addition to specification of chrome plate, is the fact that the rod shown has been reduced to

the comparatively low weight of 510 pounds through use of alloy steel. This allows considerable increase in speed, the light weight eliminating to a large degree the hammer blow effect which ordinarily develops at high speeds when heavy rods are used.

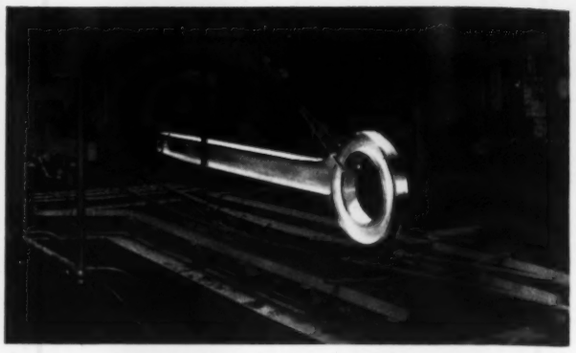


Fig. 7 — Chrome plate and alloy steel are unusual features of light weight main rod for high speed locomotive

SOLDER JOINS METAL TO PORCELAIN

IN THE Westinghouse research laboratories a process recently was developed whereby metal parts can be soldered to porcelain. From the practical point of view this solves a problem of many years standing—that of making a permanently oil and vacuum-tight joint between these two high dissimilar kinds of material. An example of the commercial application of the new process is that of the large insulator body shown in *Fig.* 8, in which two of the soldered joints are clearly visible. A special metal glaze

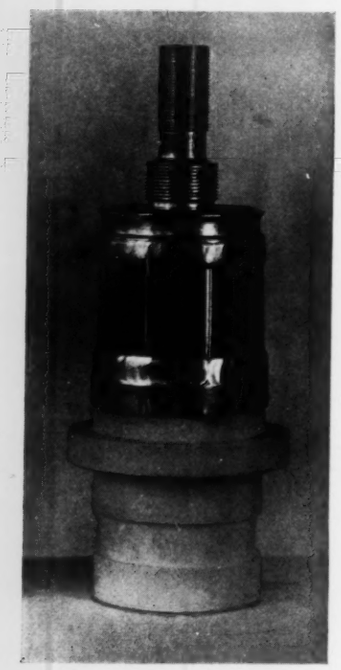


Fig. 8—Laboratory research has made possible a method of direct soldering of metal parts to porcelain, of which a practical example is furnished by this insulator assembly

is fired on the porcelain and this is tinned preparatory to soldering on the metal parts.

When production was undertaken it was found that extraordinary precautions in glazing, handling, firing, etc., were necessary, and it also was found that the plumber had to "unlearn" his traditional procedure in tinning. He could not go over his work a second time with the soldering iron and he had to keep his iron at a lower temperature than standard practice would dictate.

Before the production problems were solved, it was found necessary to build special kilns, to establish an entirely new set of rules in kiln temperatures, atmospheres, handling, cooling, etc. To accomplish all this, a laboratory man was put on production, a skilled workman being trained gradually to take his place. All this is typical of the period of transition between a laboratory development and commercial production thereof, especially when the development upsets old methods of doing things.

VIBRATION CONTROLS MATERIAL FLOW

UNUSUAL applications are constantly being found for high frequency vibration produced by electromagnetic means. A case in point is an electric volume control developed by Syntron Co., by means of which flow of dry material from a feeder conveyor can be regulated to a constant rate varying from a dribble to a full trough flow, or can be stopped instantly.

The device is shown in *Fig.* 9, together with views giving an idea of the two extremes of controlled flow produced. The separate electric controller converts standard alternating current into pulsations, which give rhythmical impulses to the feeder trough through powerful electromagnets. This rapid reciprocation, which can be varied by twisting a control knob, causes the dry material to flow through the trough.

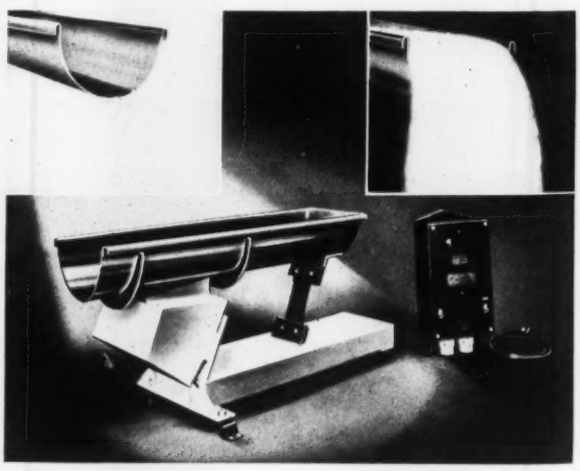


Fig. 9—High frequency vibration causes dry material to flow like water, under exact control

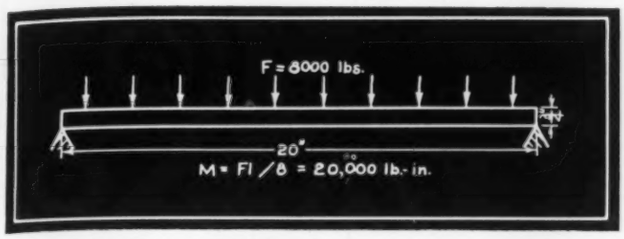


Fig. 1—Simple beam is employed to determine influence of ribs

By V. L. Maleev

Professor of Mechanical Engineering, Oklahoma Agricultural and Mechanical College

Why Add Ribs that Don't Add Strength?

RIBS ARE added to a casting to make the construction either stronger or more rigid. They always attain the latter objective, but may entirely fail in regard to the first one. If the addition of ribs lowers the maximum stress of a part, the ribs strengthen it. If the maximum stress in the original design is lowered, but the stress in the added rib is equal or higher than in the original design, the rib is either useless or weakens the part respectively. A crack may develop in the high-stressed rib, and eventually spread and cause the part to fail.

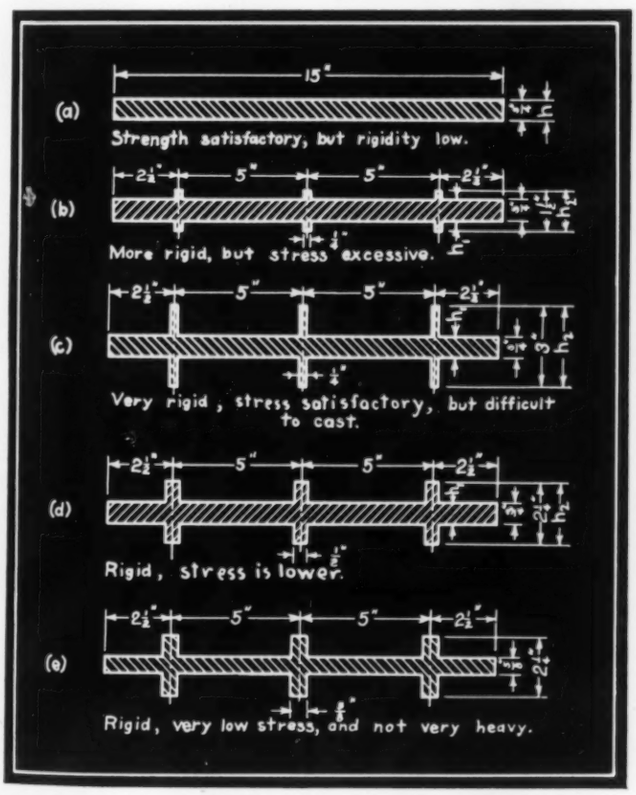


Fig. 2—By progressive steps, such as these, the proper dimensions of ribs can be ascertained

It should be remembered that the rigidity is measured by the deflection and is inversely proportional to the moment of inertia I of a section, whereas the stress s is inversely proportional to the section modulus Z. Often ribs are added without giving due thought to this fact. If the stress in the ribs is taken into account, the usual procedure is to apply the cut-and-try method as is illustrated by the following example.

EXAMPLE 1—A cast steel plate 20 inches long and 15 inches wide, supported at the ends, carries a uniformly distributed load of 8000 pounds, *Fig.* 1, and *Fig.* 2*a*. The problem is to find the influence of conventional ribs upon the rigidity and strength of the plate.

The bending moment of the load

$$M = Fl/8 = 8000 \times 20/8 = 20{,}000 \text{ pounds-inch}$$

Naturally the ribs must be in the direction of the greatest dimension, or lengthwise. Dividing the width into three strips, each 5 inches wide, and adding narrow ¼-inch ribs to double the thickness of the plate h_1, to $h_2 = 1\frac{1}{2}$ inches, the section of *Fig.* 2*b* is obtained. In TABLE I are given I, Z, and s of the flat plate a and of the plate b after the small ribs are added. The rigidity, as

indicated by the increased moment of inertia. $I_r = 0.71$ as compared with $I = 0.53$, is increased by about 35 per cent. However, the strength is decreased as the maximum stress is increased from $s = 14{,}200$ to $s = 21{,}000$.

The next type of rib, *Fig.* 2*c*, was found by changing the height h_2 so as to obtain at least the same strength. By increasing h_2 to 3 inches, the plate became $2.19/0.53 = 4.16$ times more rigid with a slight decrease of the stress, from 14,200 to 13,700, TABLE I. However, actually such thin and high ribs will be very difficult to cast and they will cause additional stresses from the abrupt change of the thickness from ¾ to ¼ inch.

A better type of rib is shown in *Fig.* 2*d* and TABLE I; the height of each rib is equal to the thickness of the plate, the width of the ribs is twice that of the two previous attempts. TABLE I shows that the rigidity is only slightly smaller than in type *c*, but the strength is increased about 20 per cent above that of the flat plate. The weight W is not affected by the ribs to any extent.

Finally, *Fig.* 2*e* and TABLE I give the data for a plate which has a still greater rigidity, greater strength and is very little heavier than the flat plate. In this case the body of the plate is made thinner and the ribs are of the same thickness as the plate. This plate will also have very small internal casting stresses and little stress concentration.

USE OF DIAGRAMS—In view of the wide use of ribs it seems desirable to have a quicker and better method than cut-and-try for determining the proper dimensions. This method can be derived by taking a plate strip which must be reinforced by a rib and considering it as a beam *A, Fig.* 4, with a rectangular section supported at the ends and loaded at the center[1]. The deflection of any beam due to a moment M is inversely proportional to the moment of inertia I. For this beam

$$I = b_1 h_1^3/12 \qquad (1)$$

To make the beam more rigid, two symmetrical ribs may be added forming a cross, beam *B Fig.* 4. For this ribbed beam

$$I_r = [(b_1 - b_2)h_1^3 + b_2 h_2^3]/12 \qquad (2)$$

The obtained increase of stiffness or decrease of deflection can be measured by the ratio $r_1 = I_r/I$. Using the expressions (1) and (2) and introducing the designations $m = b_2/b_1$ and $n = h_1/h_2$ gives

$$r_I = 1 - m + (m/n^3) \qquad (3)$$

since $n < 1$, therefore $r_1 > 1$ at all times.

The stress due to a bending moment is inversely proportional to the section modulus. For the original beam $Z = I/0.5h_1$ and for the ribbed one $Z_r = I_r/0.5h_2$. Expressing the change of strength by the ratio $r_z = Z_r/Z$ it is easy to see that although $I_r > I$; but if h_2 is sufficiently great, Z_r may be smaller than Z and $r_z < 1$. With the same notations as before

$$r_z = [1 - m + (m/n^3)]\, n = n r_I \qquad (4)$$

Designating the weight of the original beam by W, that of the ribbed one by W_r, and the ratio of the weights W_r/W by r_w and using the former notations gives

$$r_w = 1 - m + (m/n) \qquad (5)$$

Equations (3) and (5) can be applied to plates and walls with spaced lengthwise ribs. In this case m designates the ratio of the rib width to the distance between the rib centers.

These equations are presented graphically in *Fig.* 4 with the values of n taken as abscissae and the values of relative strength r_z as ordinates. From equation (4) it follows that the curves of equal rigidity $r_1 = \text{const.}$ are straight lines converging at 0, the beginning of the coordinates. Connecting the points of equal relative weight, $r_w = \text{const.}$ the dotted curves were

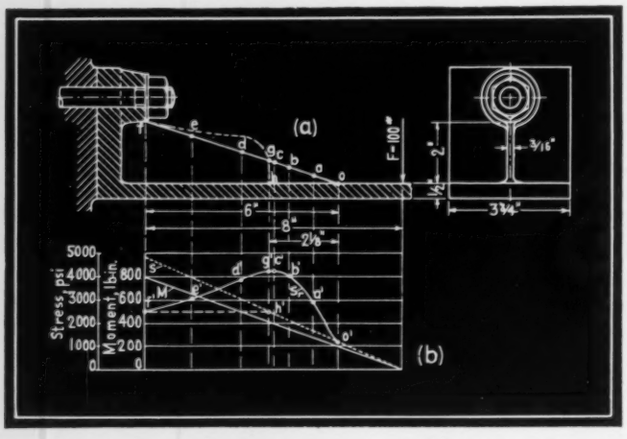


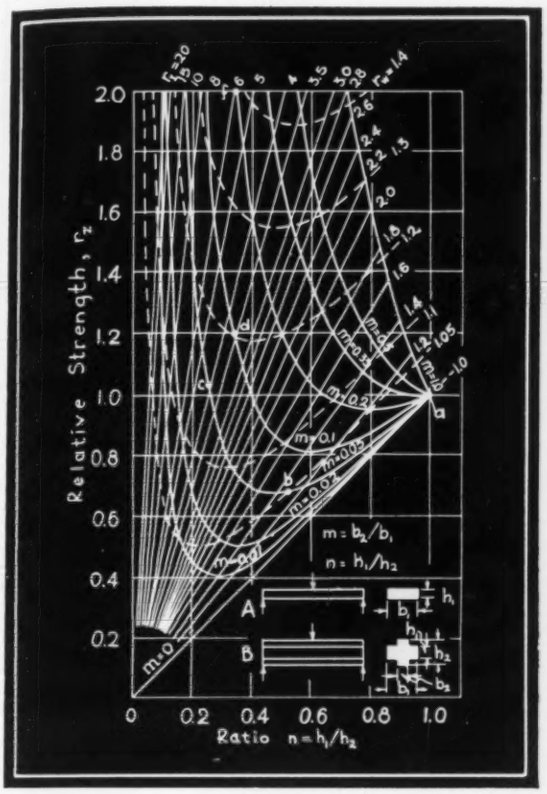
Fig. 3—*Plate strip which must be reinforced can be considered as a beam for calculations*

[1]Thum, A., and S. Berg, *Zeitschrift VDI*, vol. 77, 1933, p. 281-287.

TABLE I

Influence of Ribs on Rigidity and Strength

Section of plate *Fig.* 2	I in.⁴	Z in.³	W lb.	s psi	b_2/b_1 m	h_1/h_2 n	Checked by *Fig.* 3 r_1	r_z	r_w	From *Fig.* 6 r'_z
a	0.53	1.41	63.0	14,200	1	1	1	1	1	1
b	0.71	0.95	63.2	21,000	0.05	0.5	1.35	0.68	1.05	0.58
c	2.19	1.46	72.5	13,700	0.05	0.25	4.16	1.04	1.15	0.52
d	1.90	1.69	75.6	11,800	0.1	0.33	3.60	1.20	1.20	0.63
e	2.44	2.17	69.6	9,200	0.13	0.28	(4.60)	(1.54)	(1.10)	(0.70)
(*f*)	3.18	2.82	87.0	7,100	0.2	0.34	*6.0*	*2.0*	1.38	0.84



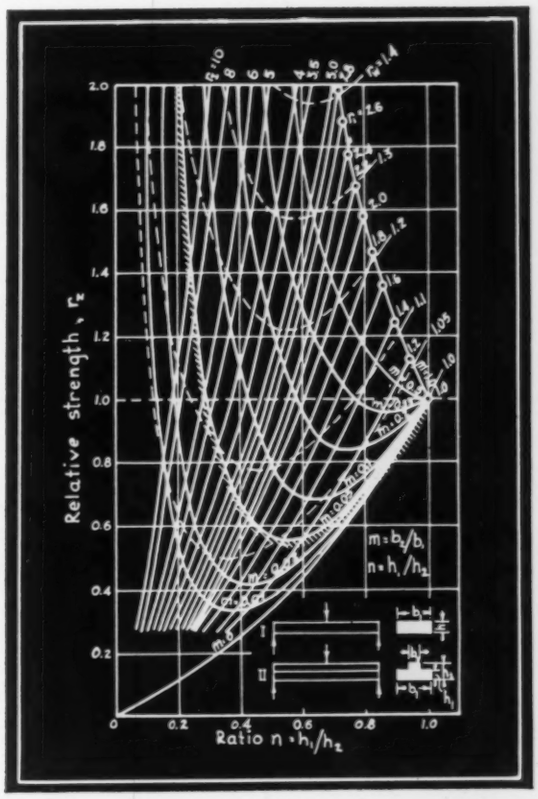


Fig. 4—Left, Above—Diagram may be used to find the relative rigidity, strength and weight of a ribbed strip. Fig. 5—Right, Above—Relative strength of rib can be determined by this chart. Fig. 6—Below—Diagram serves to find the influence of certain types of ribs upon the stress in regard to impact or shock loads

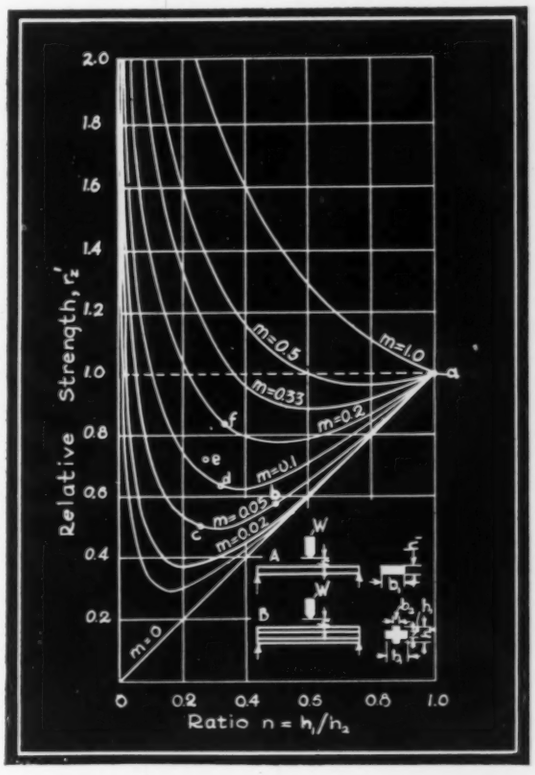
obtained. For $r_w = 1$, the curve is a straight line inclined at 45 degrees and coincides with the curve $m = 0$.

This diagram may be used to find the relative rigidity, strength and weight of a ribbed strip as compared to a flat one. Having found the values m and n for the ribbed plate, its characteristics are found at the intersection of the corresponding curve of m with the vertical line drawn through the corresponding abscissa n. In this manner the points a, b, c and d, *Fig.* 4, which give the characteristics of the corresponding sections discussed in Example 1, were located and entered in TABLE I. Section e cannot be located as it has for its basis a different thickness h_1.

Fig. 4 shows clearly that there are many ribs which actually weaken a part. Such are all ribs for which the points of intersection of m and n are below $r_z = 1$.

EXAMPLE 2—Determine the size of ribs to be added to the flat plate, *Figs.* 1 and 2, to increase its strength two times and its rigidity at least four times.

The condition of strength means $r_z = 2$, or any point on the upper edge of *Fig.* 4. The condition of rigidity is $r_i >= 4$. This indicates that $m \leq 0.5$. Since the relative weight r_w decreases with a decrease of m, it seems advisable to select $m = 0.2$, which gives point f on *Fig.* 4 and at the same time gives without any further



calculations $r_i = 6$, $r_w = 1.38$, $n = 0.34$. Thus the dimensions are: $b_2 = b_1 m = 5 \times 0.2 = 1$ inch; $h_2 = h_1/n = 0.75/0.34 = 2.21$ or $2\frac{1}{4}$

inches. The weight $W_r = W \times r_w = 63 \times 1.38 = 87$ pounds.

By a similar procedure, a chart, *Fig.* 5, was constructed for any one-sided, unsymmetrical arrangement of ribs.

EXAMPLE 3—The point of action and the magnitude of the maximum stress in a rib put in to reinforce an aluminum bracket, *Fig.* 3*a*, must be determined.

Ratio of Stresses Is Relative Strength

In this machine part the width of the rib b_2 is constant and therefore the ratio $b_2/b_1 = m$ is also constant, $m = 0.188/3.75 = 0.05$. The height of the rib varies, increasing from 0 to 2 inches, and therefore the characteristic ratio $n = h_1/h_2$ varies from $n = 0.5/0.5 = 1$ to $n = 0.5/(0.5\text{-}2) = 0.2$. The stresses at various points of the outer edge of the rib may be found by comparing them with the stresses in the bracket before the rib was put in. The ratio of these stresses was termed the relative strength of the rib and designated by r_z, *Fig.* 5. In the latter the curve $m=0.05$ is brought out by a shading.

First are drawn in *Fig.* 3*b* the lines of bending moments M and of the corresponding stresses s of the bracket without the rib. The curve s_r of the stresses with the rib was obtained by finding for the consecutive points *a, b,. . . f* the values of $n=h_1/h_2$. Through these points of n in *Fig.* 5 were drawn ordinates to the intersection with the curve $m=0.05$ and the corresponding values of relative strength r_z read. The stress s_r is equal to the stress *s, Fig.* 3*b*, divided by the corresponding value of r_z. Thus the curve *a'-b'-'-d'-e'-f'* was obtained. Its highest point *g'* gives the maximum stress in the rib $s_r=4200$ pounds per square inch and locates the corresponding point *g* of the rib 2⅛ inches from its lower end.

Chart Eliminates Tedious Job

Without the chart of *Fig.* 5, the plotting of the curve s_r is a rather tedious job which usually is left undone.

Fig. 3*b* shows clearly that the rib laid out in the conventional way does not do much good. The highest stress in the rib $s_r=4200$ pounds per square inch, which is but little less than 4880, the stress *s* without the rib.

EXAMPLE 4—Determine the shape of the rib in Example 3 at the condition that the maximum stress will not exceed that at point *f*, i.e. 2500 pounds per square inch. By using *Fig.* 5 it is easy to find the shape of the rib which will give a more desirable stress curve *o'-h'-f'*. The ratios of the stress without the rib to the constant maximum stress $s_r=2500$ pounds per square inch taken for several points will give the desired relative strength r_z for these points. The intersection of r_z with the curve $m=0.05$ on *Fig.* 5 gives the desired value of n and hence the necessary height $h_2=h_1/n=0.5/n$. By this procedure the new shape of the rib shown by a dotted line, *Fig.* 3*a*, was obtained.

Another, better solution of the rib problem would be according to *Fig.* 5 to increase the thickness b_2 of the rib at least to ⅜-inch. This would give $m=0.375/3.75=0.1$. Still better will be to make $b_2=¾$-inch which corresponds to $m=0.2$. The rib will become lower, easier to cast. The increase of weight will be very small as indicated by the curves r_w of relative weight, *Fig.* 5.

IMPACT LOADING—It was already shown that in order to decrease the danger of failure through impact loads the resilience of the part involved must be increased which, in turn, requires greater deformations. Since ribs act in the opposite direction, it is obvious that they are not desirable where impact loads are expected. By an analysis similar to that applied to static loads the ratio of the magnitudes of the impact stress of a flat plate s' to that of a ribbed plate s_r' can be expressed as a function of the same factors m and n. This ratio may be designated by r_z', since it has the same meaning as r_z for static loads.

$$r_z' = s'/s_r' = f(m, n) \qquad (6)$$

For symmetrical ribs of a cross-like shape

$$r_z' = \sqrt{(1-m)n^2 + m/n} \qquad (7)$$

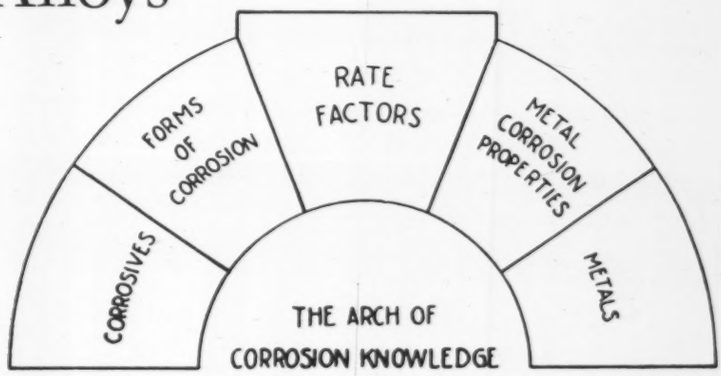
Equation (7) is represented graphically in *Fig.* 6. This diagram may serve to find the influence of a certain type of ribs upon the stress of the piece in regard to impact or shock loads. From this diagram were found the values of r'_z for the ribbed sections of *Fig.* 2 and entered in TABLE I and in *Fig.* 6, points *a, b, c, d, e,* and *f*. *Fig.* 6 and TABLE I show clearly that the strength of a ribbed construction under shock loading is smaller than that of an unribbed less rigid construction. Increased impact strength, $r_z'>1$, is obtainable only with very wide ribs, $m \leqq 0.5$, or very high ribs, small n, which means a considerable increase of the weight.

Fluctuating loads have a similar, although not so pronounced, effect as shock loads and therefore all conclusions about the latter in regard to ribs apply to fluctuating loads as well.

GENERAL CONCLUSIONS—Ribs should be used chiefly for static loads. Wide and low ribs are safer than thin and high ones. The stress and rigidity conditions can be easily estimated and the proper rib dimensions selected using charts *Figs.* 4, 5, and 6.

The accuracy of values obtained by means of these charts is about ±5 per cent, which is sufficient for all practical purposes. The saving of time is very considerable, 75 to 90 per cent, and the procedure is so simple and so easy to check that the danger of error in the design is greatly reduced.

Corrosion Resistance of Metals and Alloys



Designers can forestall trouble by selecting materials according to rules given in this recently published book on metallurgy.

MACHINE designers today have to contend with some problems far beyond immediate ones of mechanical performance, speed, appearance and structural strength. The most serious of these, and at the same time the most subtle, are those of corrosion. With increasing mechanization in the food, beverage, chemical and pharmaceutical industries, together with increasing industrial use of chemical substances as in cutting compounds and in certain types of lubricants, a convenient source of practical knowledge of corrosion resistance of metals and alloys is something that every designer needs.

Machines which are designed incorrectly from the standpoint of corrosion resistance not only carry within themselves seeds of premature disintegration but also they may menace the health of thousands of people who will use foods, beverages or drugs processed or handled by them. In large organizations design problems involving corrosion are — or at least should be — solved by co-operation between the designers and the staff or consulting metallurgists. In plants which do not have the regular services of metallurgists however, danger that some important detail susceptible to dangerous corrosion will "get by" the designers is ever present. The subject is so large and its bibliography so voluminous and scattered that to the average machine designer any attempt at a general study of it heretofore has seemed rather hopeless.

Something definitely has been done about this situation by Robert J. McKay and Robert Worthington. The result of their meritorious co-operative work now is made available to engineers, designers and metallurgists by the American Chemical Society as the latest in its series of scientific and technologic monographs. This 492 page book entitled, *Corrosion Resistance of Metals and Alloys,* covers the subject thoroughly without being unduly theoretical. Its spirit is thus expressed by the authors in their introduction:

Authors Stick to Essential Facts

"The engineer or industrial chemist who has the problem of making a machine or structure last as long as possible in corrosive conditions should have a general knowledge of how corrosion works, but the following of the various theories involved to their ultimate end may interfere with his practical decisions. Thus, in explaining and classifying corrosion, we will not delve into the theories of electrochemistry, of acid-metal reactions, of oxidation, of diffusion or of metal structure, although it is recognized that each of these has its bearing on the subject. We will assume certain accepted theories as true and we will be subject to the skepticism of those who do not accept them."

Designers will be able to find practical answers to their corrosion problems without going beyond this book. If however one does see

(*Concluded on Page* 76)

Fig. 1—Grooving assures correct distribution of lubricant

Phenolic Plastics—Desig

By O. K. Graef

BEARINGS made of phenolic plastics have come into wide-spread use in the steel industry during the past six years, and to a somewhat lesser extent have penetrated the paper, textile and cement industries. Their rapid acceptance in the steel industry has been due to their bearing qualities—and in spite of their disadvantages.

In the fields of smaller, lighter machines only slight use has been made of the resin bearing for a number of reasons, chief of which is the lack of their development and exploitation on the part of the bearing manufacturers. The time has finally arrived, however, when it is becoming profitable to manufacture these smaller bearings and an ever-increasing activity in this line is to be expected.

Summarizes Available Data

For this reason it would seem apropos at this time to present a summation of the experience available on this subject, although it is recognized that this is relatively incomplete because of the small amount of data available concerning the smaller bearings installed. Especially is this true of oil-lubricated and the so-called oilless bearings (preferably called prelubricated bearings).

It has been found that a bearing composed solely of resin, without any filler or reinforcement, is unsuited for ordinary bearing use except in cases where the loads are minute, as in some electrical instruments. Some reinforcing agent is essential in order to bring out the good qualities of the resin to the fullest extent. Wood flour has been used and has been found to be completely unsuitable. Wood shavings in the form of excelsior are found to have good antifrictional qualities under conditions of water lubrication, but are fragile with respect to shock loads, impact and vibrational stresses. Paper was used as the reinforcing agent in some of the earlier types of bearings and was found to overheat readily, scoring the journal and seizing the shaft. At the present time paper is only used for bearings where the loads are light or the speed is slow, but even in these positions it is definitely inferior to the fabric bases and is gradually falling into disuse. Asbestos fibers are also being used.

Most of the bearing manufacturer have finally settled on various fabrics, such as linen, cotton duck and cotton belting, as these materials reinforce the resin perfectly without any sacrifice of the low frictional coefficient of the pure resin alone. For light duty bearings and bear-

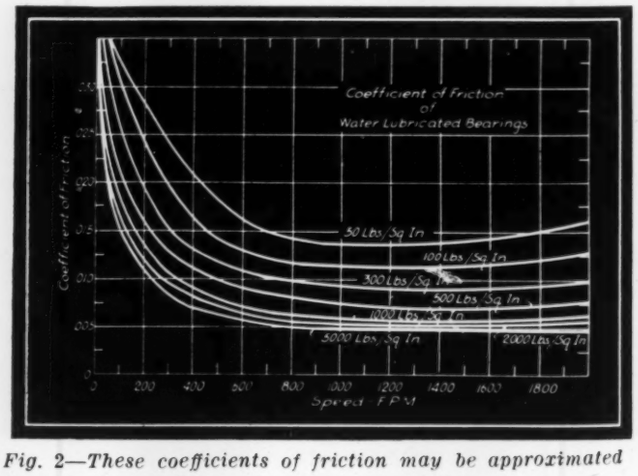
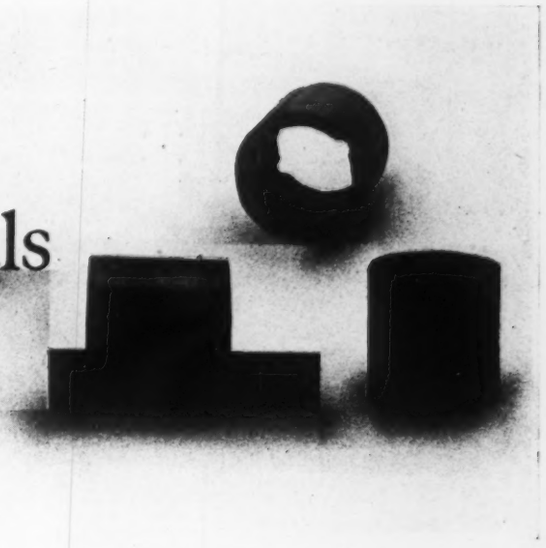


Fig. 2—These coefficients of friction may be approximated under ideal operating conditions

Fig. 4—When oil is employed, 360-degree bushings are necessary



Latest Bearing Materials

Part I

ings of small size, the linen and cotton duck fabrics of various weights are generally in use, while for heavy duty and larger bearings the cotton belting material is preferred. Bearings of this latter type are in use today, operating under loads in excess of 5000 pounds per square inch, with water lubrication, and showing no increase of friction loss over other types of bearings, with a practically equivalent life.

Since the inception of the plastic bearing there has been a constant improvement in the resins used. Today, resins may be produced for nearly any specific purpose. They are available for use in and around food products, and for this duty are made absolutely odorless so that the food will not be contaminated. Resins to withtand many strong acids and some alkalis are available, and from them bearings may be made which will operate over long periods while immersed in the substance. Admixtures of alkaline earths, volcanic ash, lead, tin and zinc compounds and graphite are included in many instances to assist in the production of a bearing for specific uses. At present, each manufacturer has his own definite ideas on the subject, and but little has been done in the way of standardization. For this reason it is advisable for the designer to lay his problem before the manufacturer and be guided by his recommendation as to fabric, resin and mixture.

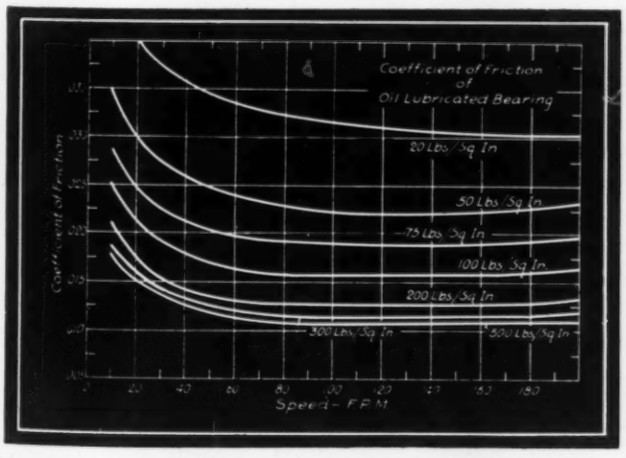


Fig. 3—Ideal coefficients of friction to be expected with light loads and oil lubrication

Journal Should Be Hardest

Physical data on ordinary resin bearings with cotton fabric or cotton belting reinforcement are shown in TABLE I. The data in this table are given for reference but it should be borne in mind that the physical characteristics are not always a certain method of indicating the qualities of a bearing. As a rule, the journal should be harder than the bearing, and to as great a degree as possible if the best antifriction and wear characteristics are to be realized. For this reason the brinell hardness is of value, although strictly speaking it does not give a true index of the hardness owing to the resilience.

Plastic bearing materials have, in general, low bending strengths, and for this reason bearings should be so designed that no part of the bearing is subjected to bending stresses. The bearing should be evenly supported all over.

When bearings of the bushing type are to be assembled, they should never be assembled into their sleeve with more than a light push fit, but should fit the sleeve or backing evenly all the way around. The reason for this is that water absorption by the resin and fabric causes

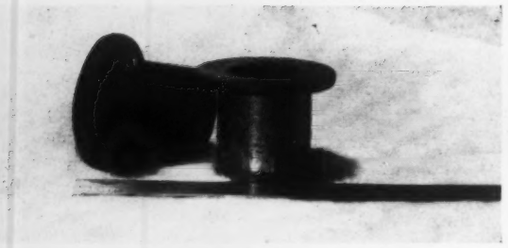


Fig. 5—Prelubricated bushings can be obtained in many forms

a certain amount of swelling, and if the bushing fits its sleeve too tightly the swelling will act to reduce the internal diameter of the bushing causing it to pinch and thus overheat.

The bore of such a bushing should always have a running clearance of at least three-thousandths inch per inch of diameter or fraction, to insure that the initial swelling due to the oil or water lubricant will not cause pinching. After several hours of operation it will be found that this initial clearance has been reduced to about one to two-thousandths inch per inch diameter which is about right.

Element Friction Varies

The theory of bearing friction has been well explained by several investigators as the fluid friction or shear of a layer of the lubricant under conditions of perfect film lubrication. The friction of practical machine elements, however, is only rarely completely fluid but varies between the lower boundary of full film lubrication to the upper boundary of dry or unlubricated friction. Investigations into this phase of the mechanics of friction, within which lies practically all practical machine bearings, has been more or less unsuccessful. For this reason, any practical determination of actual frictional conditions is nearly impossible without tests.

Dry friction has been stated to be a problem of elasticity and the work of friction is a displacement work. As the load on a bearing is increased until the breaking strength of small irregularities of the shaft and/or bearing are exceeded, material is removed from the surfaces and deformation work replaces displacement work.

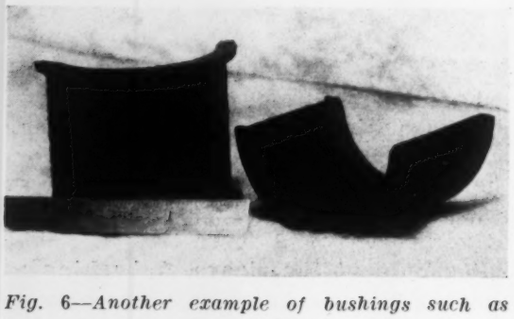


Fig. 6—Another example of bushings such as those in Fig. 5

Phenolic plastic bearings being tougher than metallic bearings, they are much more durable within wider limits of direct stress, while at the same time the displacement work is less, thus resulting in much lower frictional coefficients. The practical demonstration of this can be noted when plastic bearings are first installed against a new journal. At first, the journal is rapidly polished to a smooth surface, and the bearing indicates some wear. Later, within a few hours to a week or more, depending upon the load and speed, the polishing action decreases to a minimum, the removal of material from the shaft and bearing practically ceases and the frictional coefficient falls to a minimum. In addition to this, as the bearing and journal become polished, the surface of the resin bearing work-hardens and eventually a steady frictional coefficient of a low order is established and maintained.

Phenolic plastic resins have two inherent

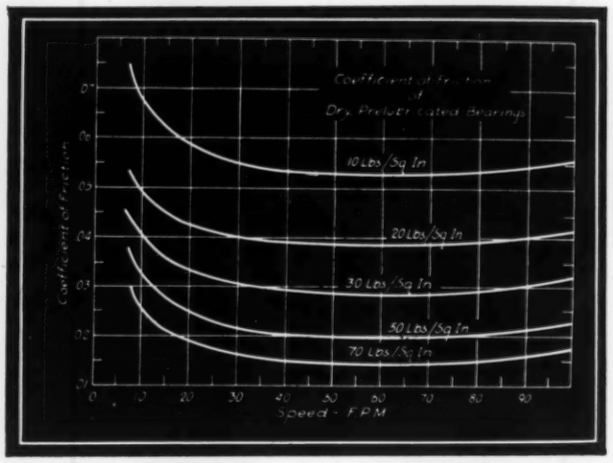


Fig. 7—As wear in prelubricated bushings is rapid, these values may have to be increased

disadvantages which attend their use as bearing materials. These are their high resistance to deformation (or elasticity) and their high resistance to heat transfer. TABLE I indicates a thermal conductivity for plastic bearings of 0.26 to 0.32 Btu. per square inch per hour per degree Fahr., per inch thickness and this is only about 0.2 to 0.3 per cent of the heat transferred by metallic bearings. It is obvious, therefore, that most of the heat generated by friction in the bearing must be conducted away by the shaft, and if this is greater than the shaft can dissipate before the working temperature of the bearing is raised to a point in excess of the safe working temperature of the bearing material (275 degrees Fahr.), then some form of external cooling means must be provided. This can be done most economically by cooling and lubricating with water, or by cooling and recirculating the oil supply. It should not be overlooked that the generation of heat in a plastic

bearing is only one-fifth to one-tenth that generated in a metallic bearing because of the lower frictional loss; for this reason, plastic bearings may in many cases be used without the necessity of providing additional lubrication.

The high resistance to deformation of the plastic resin bearings, their other disadvantage from a bearing standpoint, requires that they be installed in perfect alignment. Metallic bearings, if slightly misaligned, will overheat and the resultant loss of resistance to deformation will allow the metal to flow slightly under the load, thus correcting the alignment, when the temperature of the bearing will fall; the metal regains its hardness and the bearing will from then on function perfectly. The plastic resin bearings, on the other hand, are incinerated by excessive heat with only slight effect on their deformation. Therefore, it follows that alignment of a higher order of accuracy than is customary with metallic bearings must be attained if good results are to be expected.

TABLE I

Physical Characteristics of Ordinary Resin Bearings with Cotton Reinforcement

Specific gravity	1.36
Modulus of elasticity	1,500,000
Weight per cubic inch, pounds	0.8
Tensile strength, with grain, pounds per square inch	9,400
Tensile strength, across grain, pounds per square inch	7,000
Bending strength, pounds per square inch	18,000
Compressive strength, flatwise, pounds per square inch	37,500
Compressive strength, edgewise, pounds per square inch	25,000
Water absorption, 100 hours immersion, per cent	1.07
Brinell hardness, 500 kg load, 30 sec	30
Scleroscope hardness	75
Maximum operating temperature, degrees Fahr.	275
Thermal coefficient of expansion	30×10^{-6}
Coefficient of friction, dry	0.280
Thermal conductivity, BTU/square inch/hour/-degree Fahr./inch	0.26 to 0.32

Fig. 2 indicates the coefficients of friction which may be approximated under ideal operating conditions with bearings perfectly installed. Under normal operating conditions, with an ample supply of clean cool water applied directly to the exposed shaft, the friction will be 5 to 10 per cent higher. The arc of contact of the bearing to the shaft must not exceed 240 degrees total, of which not more than 150 degrees of bearing is beneath the center of pressure and not more than 90 degrees is used as the cap or nonpressure side of the bearing.

Fig. 3 indicates the ideal coefficients of friction to be expected with light loads and oil lubrication intermittently applied by a drop oiler or similar oil feed device. The practical coefficients will in this case also probably range some 5 to 10 per cent higher than the ideal figures given. When oil is used for the lubricant on small bearings they may be 360-degree bushings, but they must be grooved somewhat as shown in *Figs* 1 and 4 in order to assure proper distribution of the lubricant. If the loads are to be in excess of 100 pounds per square inch, then this small groove will be ineffective and the bearing should comprise not more than 240 degrees contact of bearing to shaft as in the case of water lubrication.

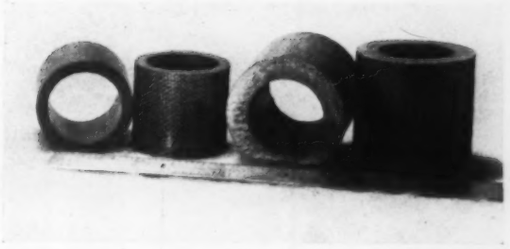


Fig. 8—Plastic bearings usually have high starting friction

Fig. 7 indicates the ideal frictional coefficients for small prelubricated bushings such as are shown in *Figs.* 5, 6 and 8, while *Fig.* 9 indicates a new type of this bearing composed of new lubricating materials. The wear in this type of bearing is usually quite rapid, and for normal use the values shown in *Fig.* 7 should be increased 10 to 25 per cent depending upon the cleanliness of the surroundings.

Frictional Coefficient High

In this connection it should be noted that journals which run close to the upper limit of dry friction operate at very high coefficients of friction, and in this zone the friction and hence the heat generated vary greatly with only slight changes of load and speeds. With small loads and high velocities of rotation, the coefficient of friction is large even with the best lubrication.

The starting coefficient of friction of plastic bearings is usually 20 to 25 per cent higher than for metallic bearings and this should be borne in mind when calculating the power requirements for starting.

Typical applications of these bearings and design information on applications will be discussed in the second section of this article, to be published in the October MACHINE DESIGN.

Fig. 9—New type of prelubricated bushing employs improved materials

Every Patent Action Needs I

By George V. Woodling

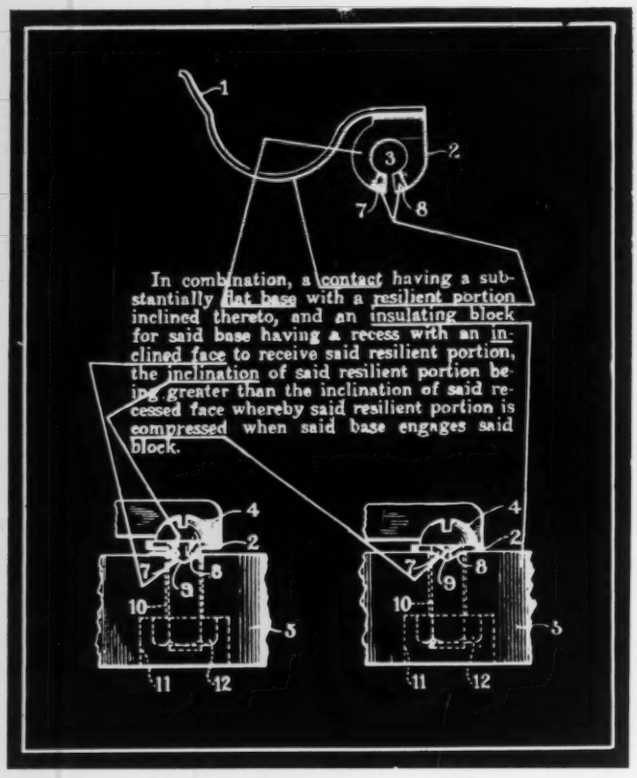
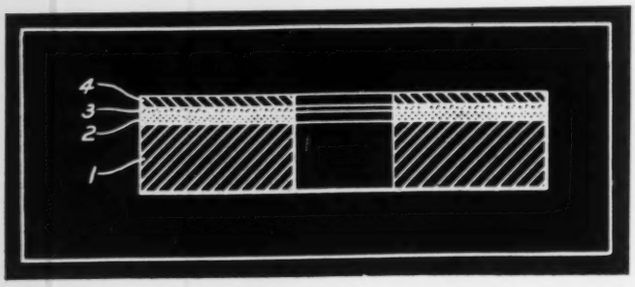

In combination, a contact having a substantially flat base with a resilient portion inclined thereto, and an insulating block for said base having a recess with an inclined face to receive said resilient portion, the inclination of said resilient portion being greater than the inclination of said recessed face whereby said resilient portion is compressed when said base engages said block.

Fig. 1—A patent claim "reads on" a device if there can be found in the device an element within the purview of each descriptive phrase of the claim

Fig. 2—Despite the fact that the theory of action between copper blank 1, oxidized coating 2, graphite 3 and plates 4 could not be described, a patent was granted on this copper-oxide rectifier .



PATENT law is different in many respects from other law. Therefore it is not good business policy, when dealing in patents, to rely too strongly upon your general knowledge of the law relating to other phases of business. A company may feel that it is doing the safe thing relative to its patent matters, and yet later learn that it has done the wrong thing. The only safe rule to follow is to check the circumstances and the law surrounding each particular problem before going ahead.

The importance of the foregoing is realized by an examination of the following examples of correspondence carried on between a manufacturer and a patent attorney. These examples set forth typical questions, but have been *modified* and reduced to exclude other matter.

Example I

Manufacturer's letter Less than two months ago our company started to manufacture and sell our new type A-1 machine. This machine is an important improvement over our former type A machine and is covered by our patent No. L307R. Much to our surprise we received a letter from Mr. John Thomas notifying us that our new machine includes certain features which infringe his patent No. A975P. We did not consult you before going ahead with our new manufacturing program, because, as a matter of general knowledge, we thought that since our new machine was patented we were free to manufacture and sell it without being sued for infringement.

We are of the opinion that Mr. Thomas is mistaken about the charge of infringement, particularly in view of the fact that we have a patent upon our new machine, but would like to have your comments before replying to him.

Patent Attorney's letter *Upon general principles, it is easy for a person to assume that a patent gives its owners the right to manufacture and sell the patented device. But this assumption is not true. Strange as it may seem, there are a large number of patented devices which cannot be manufactured and sold without infringing other earlier and dominating patents. This is the case with your own type A-1 machine*

An examination of the Thomas patent with reference to your new machine reveals that the alleged charge of infringement appears to be fairly well founded. However, I

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Individual Study

have a few suggestions as to how you can change the design of your machine to avoid the alleged charge.

It is well to bear in mind that a grant of a patent is not a license to manufacture and sell the patented device, but only gives its owners the right to prevent others from the unauthorized manufacturing, selling and using of the patented machine. In other words, patents do not give the inventor a positive right, but instead a negative right of exclusion. This is true even though the patented device constitutes a vast improvement over the earlier patented devices. New patents can be granted on improvements, and thus others can be prevented from manufacturing or selling machines with these improvements, although it may not be possible to manufacture and sell the improved machine without a license agreement because certain basic factors in it are covered by earlier dominating patents.

Manufacturer's letter Replying to your letter, we do not want to change the design of our machine, if we can possibly avoid it. We have already spent a large sum of money in the designing department, as well as in the plant for tooling up for production. To make a change in our design as suggested by you would not only cost more money but would also constitute a waste of the money already spent, and in addition would probably cause delay and changes in our manufacturing production methods.

I do not quite understand how our new machine can possibly infringe the Thomas patent, because our machine does not have any resemblance whatsoever to the drawing illustrated in that patent.

Patent Attorney's letter *"Looks" is not the true test of infringement for mechanical patents. The fact that your machine may have more parts than the machine illustrated in the Thomas patent does not free you from infringement. If the principle and the mode of operation of the Thomas patent are embodied in your machine, the mere changes of the position or the form of the mechanical elements thereof does not avoid infringement.*

Explaining the attorney's letter more specifically, the true test of infringement is whether or not a claim or claims of the Thomas patent "reads upon" the new type A-1 machine. A claim of the patent "reads upon" the machine if there can be found in the said machine, elements which fall within the purview of each descriptive phrase of the said claim. As an illustration of this point let us take a simple device such as the one shown in *Fig.* 1. There can be found in this device an element that falls within the purview of each descriptive phrase of the claim illustrated below it. Therefore the manufacture, sale and use of the device would constitute an infringement of the accompanying claim.

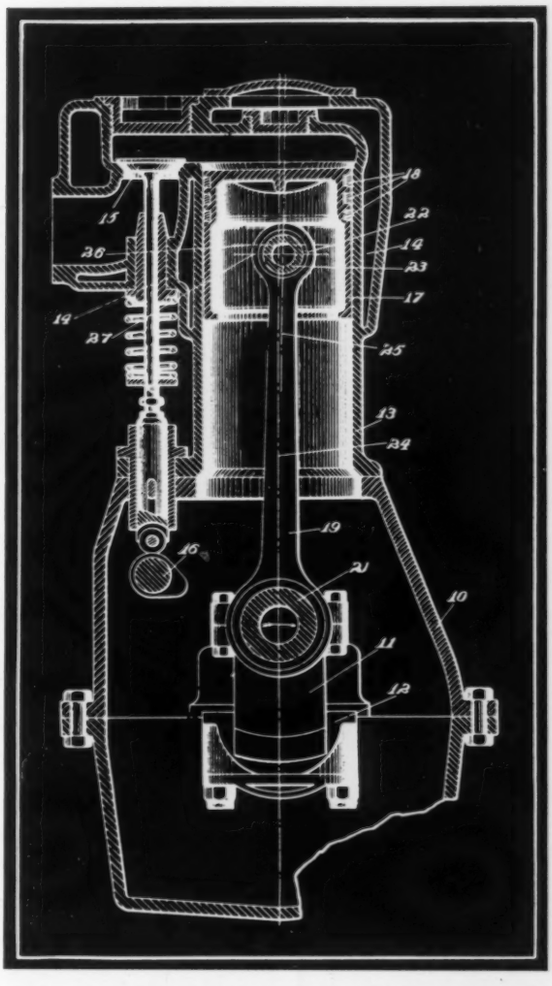


Fig. 3—*Mere invalidity of the patent on this mechanism was no defense in a royalty suit*

Example II

Manufacturer's letter About a year ago an inventor by the name of James Smith came to our company and showed us a full size working model of an attachment which was arranged to fit upon our general line of machines. At the same time he showed us a copy of his patent which appeared to cover his invention. We gave the attachment a tryout upon our machines and it proved successful. The sales department was very much interested in acquiring rights to the attachment because they thought it would increase the sales of our own machines as well as make a new item to increase the volume of our business. Without investigating the patent situation, our company took out a license under Mr. Smith's patent and started the manufacture and sale of the attachment.

The attachment has proved very successful commercially.

Through one of our salesmen in the field we learned that our competitor had substantially copied the same attachment, making only a few changes. There is no doubt in our minds that the competitor is infringing the Smith patent. Will you please check the patent and let us know if we can stop our competitor from further activity.

Patent Attorney's letter *We have examined the patent situation regarding the Smith patent and find two things. First, in our opinion, the Smith patent is invalid in view of earlier developments in the field. Second,*

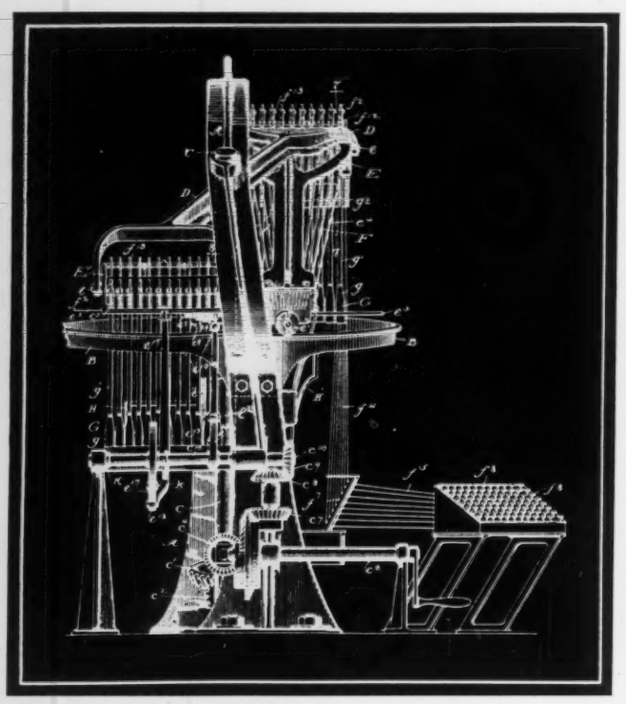


Fig. 4—Adequate proof of date of invention won patent interference for this device

we find that there is a prior patent issued to Henry Brown which dominates the field and that the Brown patent has been recently purchased by your competitor.

Manufacturer's letter If the Smith patent which we purchased is invalid, I guess we are entitled to stop paying any more royalties to Mr. Smith. I am enclosing a copy of our agreement which we signed with Mr. Smith and would like to have you read it over to see what can be done.

Patent Attorney's letter *In checking over the agreement which you mailed me, I find that there is no provision for terminating the license. Where there is no provision for termination, the terms of a license extend until the patent expires, which in your case is 15 years. If you refuse to pay Smith his royalties under the license, you are exposing your company to a suit.*

According to the majority view, the mere invalidity of a patent is no defense to a suit for royalty. Such a suit is founded upon the contract and not upon the patent.

The piston arrangement shown in *Fig.* 2 was involved in such a license suit, and the licensee strongly contended that the license agreement was void because the letters patent were invalid, but the court held otherwise.

There is considerable value in ascertaining the state of the patented art before entering upon an important development or before purchasing a patent. In the first place, it will enable the buyer to know what he is buying, and caution him against buying a worthless patent. In the second place, it will enable one to purchase adversely-held patents at a reasonably low figure because, after development activity is once started by the exploiting company, the value of such patents is greatly enhanced. In the third place, the purchase of outstanding patents will afford immediate protection and will tend to discourage infringing competition.

Example III

Engineer's letter While I was temporarily out of a job during the depression, I invented and made working drawings of a special machine for making coil springs. The cost in building this special machine was quite expensive, so I submitted the working drawings to Mr. Oliver, general manager of the A & B Spring Co., to determine if he would have his company buy the invention. He said that his company would not buy the invention, but would like to build a machine and try it out as the company was in need of a good machine for making coil springs. I permitted him to do this.

This first machine worked so well that he wanted to build nine more. Nothing was said about his company paying me anything for the extra machines, and I did not object until after all of the extra machines had been built and were working several days. Then I told Mr. Oliver I would like to be paid $200.00 for each machine, a figure which appeared reasonable. Mr. Oliver declined to pay me anything. My question to you is, what can I do? If they do not pay me anything I want to stop them from using the machines.

Patent Attorney's letter *Your letter does not mention whether or not you have a patent or a patent application pending. Assuming that you have not, there is no way to stop the A & B Spring Co., from using the first and the nine extra machines which they have built. It will do no good to apply for a patent now, and sue them for infringement upon these machines when the patent is issued. The reason for this is that you permitted the company to build and use these machines before you applied for a patent. However, had you applied for a patent before you had gone to the A & B Spring Co., you would be entitled to sue them on the strength of your patent when granted.*

Example IV

Inventor's letter Mr. T. A. Marshall and I are joint owners of a patent. He owns one-fourth and I own three-fourths. Without telling me, Mr. Marshall granted a license to the XYZ Co., from which he is now receiving a royalty. I have asked

him several times to give me three-fourths of what he receives, my share of the patent. He refuses to pay me anything. What recourse do I have?

Patent Attorney's letter *You have no recourse against Mr. Marshall. Joint inventors are at the mercy of each other. In the absence of a separate partnership agreement, each co-owner may manufacture, use and sell, or grant licenses to others to manufacture, use and sell the patented invention without the consent of the other co-owner. In fact, you have the privilege of going out and granting a license to some other manufacturer and keeping all of the royalties yourself.*

As each co-owner may separately grant licenses to competing manufacturing concerns, it is a good policy to have a separate agreement between the parties to the effect that the patent be held in partnership, wherein the mutual rights and liability of the partners are determined by the agreement and by the general law of partnership.

Example V

Manufacturer's letter Several years ago, we manufactured and sold a special machine for making wheels to the Perfect Wheel Co. We tried to sell the same type of machine to other manufacturers of wheels but had no success. Recently, due to a change in wheel designs, there has been a growing demand for this type of machine, and we have sold ten during the last month. It now appears that this type of machine is the only kind which can really do the job well.

Because of the recent commercial success of this machine, we would like to apply for a patent, because if we cannot protect the machine, it will mean that our competitors may obtain some of the business. In fact, they have already bid on two machines that we are now bidding on.

Patent Attorney's letter *Before examining the patentable merits of your new machine for making wheels, I would like to know the exact date when you sold that first machine. Also, I would like to know whether you had any advertising folders or other descriptions made of the machine and distributed to your customers.*

Manufacturer's letter Our sales record shows that the machine was shipped on August 13, 1934, and installed on August 20, 1934, which means that the machine has now been in operation a few days over two years. We made no advertising folders or other descriptions of the machine.

Patent Attorney's letter *It will do no good to apply for a patent at this time, because you have waited too long. The patent law specifies that no valid patent can be obtained on a device which has been manufactured, sold or used more than two years before applying for a patent. The law also states that no one can obtain a valid patent upon a machin which has been described in a publication for more than two years before filing a patent application. This is the reason why I inquired in my previous letter whether or not you had any advertising folders or other descriptions of the machine distributed to your customers.*

It is of interest to note that it has been held that even the sale of one single machine is sufficient to prevent the granting of a valid patent.

Example VI

Patent Attorney's letter *This is to advise you that the Patent Office has declared an "interference" between your patent application and a patent application filed by William Taber. An "interference" is a proceeding instituted by the Patent Office to determine who is the first inventor and entitled to the patent. Your application was filed on January 10th, 1934, and the Patent Office states that the Taber application was filed on March 12, 1934.*

Manufacturer's letter I do not understand this business of an "interference." I filed my application first and, as I figure it out, I should be entitled to the patent.

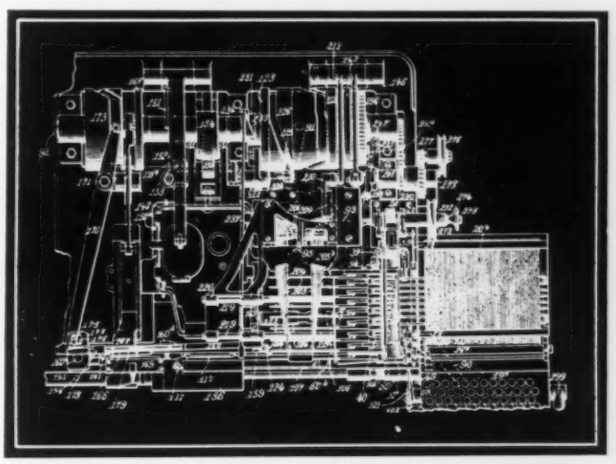


Fig. 5—Inventor of this mechanism had to carry the burden of proof in interference because of later date of filing

Patent Attorney's letter *The patent law says in effect that the first inventor is entitled to the patent. The first to file a patent application in the Patent Office, that is the Senior Party, is not necessarily the first inventor, and sometimes the second to file a patent application, that is the Junior Party, is declared the first inventor. However, the Junior Party must carry the burden of proof that he conceived the invention before the Senior Party. This constitutes a hardship. To overcome this burden, the Junior Party must take testimony first and produce drawings and sketches and written descriptions showing the earliest date of conception. Then the Senior Party is entitled to take testimony, which is followed by rebuttal testimony on behalf of the Junior Party.*

It is well established that: "The fact of conception by an inventor for the purpose of establishing priority cannot be proved by his mere allegations nor by his unsupported testimony where there has been no disclosure to others nor embodiment of the invention in some clearly perceptible form such as drawings or

(*Concluded on Page 77*)

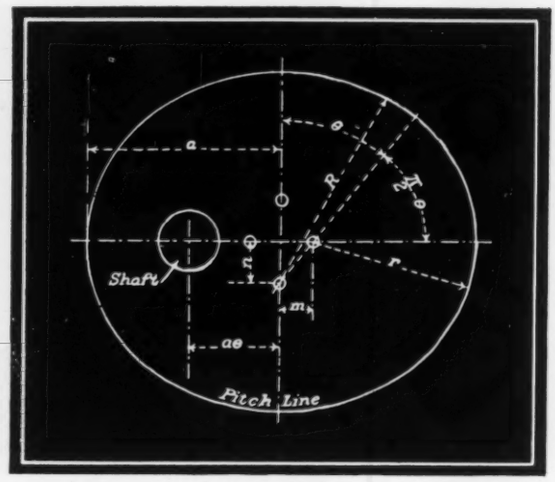


Fig. 1—Geometrical relationships encountered in the detailed design of elliptical gearing

By Frederick Grover

Cut Calculations in Design of Elliptical Gears!

THE GEOMETRICAL properties of an ellipse afford a simple means of changing the constant angular velocity of a driving shaft into the variable angular velocity of a driven shaft, for if teeth be cut upon two similar elliptical blanks, they can be mounted on parallel shafts at the focal points of the ellipses and will rotate freely between constant shaft-centers with perfect pitch line contact. If one such shaft be rotated with a constant angular velocity, the other will rotate with a variable angular velocity, dependent upon the eccentricity of the ellipse pitch lines.

To simplify the cutting of such gear wheels it has been proposed to generate an approximation to the elliptical curve by combining arcs of circles struck from selected points as centers, situated on the axes of the ellipse, so that the corresponding segments of the gears can be cut by rotating the blank about successive centers on a suitable fixture or jig.

The acceptance of such a mode of manufacture depends upon the divergence between the true elliptical curve and the closest imitation obtainable by a simple four-arc combination-curve. The geometrical relationship of the distances denoted by m and n are demonstrated in *Fig.* 1, their limiting values are defined in the formation of an elliptically-shaped figure described by combining four arcs of circles passing through the extremities of the major and minor axes of an ellipse. For any given ellipse of eccentricity e, the most appropriate relationship between m and n is $(m/n) = \sqrt{1-e^2} = \tan\theta$. This fundamental relationship leads to the determination of the radii of the arcs in terms of θ; the larger radius

$$R = a(1-\sin\theta) \div [\cos\theta(\cos\theta+\sin\theta-1)]$$

and the smaller radius

$$r = a(1-\cos\theta) \div [\cos\theta(\cos\theta+\sin\theta-1)]$$

Having derived these formulas for the con-

ELLIPTICAL gears have several properties which make them invaluable for simplifying the design of many complicated machine elements. Their use has, however, been restricted because of the difficulty in computations. These are considerably reduced by the formulas developed in a paper by Mr. Grover, chairman, Forgrove Machinery Co., Ltd., Leeds, England, presented to Institution of Civil Engineers and abstracted herewith.

TABLE I

Constants for Elliptical Gears

Maximum Velocity Ratio	Eccentricity e	$\sqrt{1-e^2} = \tan\theta$	θ: Degrees	θ: Radians	$\pi/2-\theta$: Radians	R	r	n	m	Maximum Error per in. of a	C
3.97	0.5997	0.80019	38° 40′	0.67486	0.89593	1.1848	0.6922	0.3846	0.3077	0.0054	5.67910
2.31	0.3967	0.91793	42° 33′	0.74263	0.82815	1.0643	0.86559	0.1464	0.1344	0.0019	6.0296
1.99	0.3331	0.9429	43° 19′	0.75601	0.81477	1.0433	0.90529	0.1004	0.0947	0.0013	6.1038
1.49	0.1997	0.9798	44° 25′	0.77521	0.79557	1.0145	0.9659	0.0346	0.0340	0.0004	6.2201

To use the Table, the velocity ratio required is selected, and a standard value taken for the circular pitch P of the tooth.
The desired shaft center distance of the gears ($2a$) is assumed.
The number of teeth N is made the nearest odd number to the theoretical value given by $N = aC/P$.
The number N is then inserted in the equation $NY = aC$ and the exact value of a ascertained.
The required values of R, r, n, m, for the size of gears to be used are obtained by multiplying the figures under R, r, etc., by the exact value of a.

struction of an imitation ellipse, examination of the resulting curve shows that it lies slightly within the curve of the true ellipse from the extremity of the minor axis until the curves cross at some intermediate point, defined by an ordinate y, when

$$y = 2n \times (1-e^2)/e^2 - a\sqrt{1-e^2}$$

after which point the imitation ellipse lies slightly outside the true ellipse until it merges again at the extremity of the major axis.

The greatest distance between parallel tangents to the two curves is shown to be

$$[(y_e - y_c + n)\cot\alpha + x_e - (x_c - m)]\sin\alpha$$

where x_e, y_e denote the co-ordinates where the tangent touches the ellipse and x_c, y_c the co-ordinates where the tangent touches the circular arc, α denoting the angle made by the tangent lines and the major axis. At the point of max. separation of tangents in the end segment.

$$x_e = (a/e)(1-K^{\frac{2}{3}})^{\frac{1}{2}}$$

$$x_c = (a/e)K^{\frac{2}{3}}(1-K^{\frac{2}{3}})^{\frac{1}{2}}$$

in which

$$K = (\sin\theta - \sin\theta\cos\theta) \div [\cos^2\theta(\cos\theta + \sin\theta - 1)]$$

where θ is the angle whose tangent $= \sqrt{1-e^2}$. From the values of x_e and x_c (the points of maximum separation of the tangents), y_e and y_c and the value of α are determinable.

From the formulas deduced for both segments it is demonstrable that the divergence in the end segment lying nearest the major axis is always the greater of the two.

Numerical calculations show that a pair of elliptical gears constructed for a 4 to 1 velocity ratio by the method evolved would have pitch line divergence of 0.005-inch per inch of maximum wheel radius, whereas if the velocity ratio be 1.5 to 1 the maximum error involved would be 0.0004-inch per inch and would be negligible for gears up to say 10-inch diameter.

Since the error involved is dependent on the product ae, and the velocity ratio obtainable is dependent solely upon e, it follows that a low velocity ratio in the case of large diameter wheels may involve the same error as a high velocity ratio with wheels of small diameter.

When α denotes the angle between the major axis of the driving wheel and the line joining the centers of the shafts, V the velocity ratio and e the eccentricity,

$$V = (1-e^2) \div (1+e^2-2e\cos\alpha)$$

The maximum and minimum values of V may be derived by putting $\cos\alpha = +1$ or -1. Thus $V = (1+e)/(1-e)$ for maximum, and $(1-e)/(1+e)$ for minimum. Also when $V = 1$, $\cos\alpha = e$.

The angular acceleration of the driven wheel

$$= \pm\left[\frac{2e(1-e^2)\sin\alpha}{(1+e^2-2e\cos\alpha)^2}\right]\omega^2$$

where ω denotes angular velocity of driver.

The maximum acceleration occurs when

$$\cos\alpha = \sqrt{2+[(1+e^2)/4e]^2} - (1+e^2)/4e$$

If P denotes the circular pitch of a standard form of tooth and N the number of teeth, then the contour of the pitch line suitable is

$$N.P. = 4\left\{R\theta + r[(\pi/2) - \theta]\right\}$$

where θ is expressed in radians, $\tan\theta = \sqrt{1-e^2}$, and R and r denote the radii of arcs described from n and m respectively, *Fig.* 1.

Putting R and r in terms of α and θ,

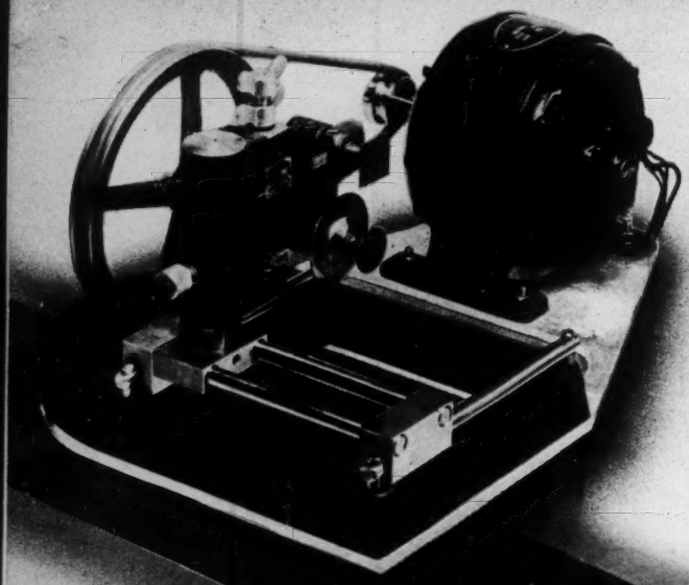
$$N.P. = \left\{4a \div [\cos\theta(\cos\theta + \sin\theta - 1)]\right\} \times \left\{\theta(1-\sin\theta) + [(\pi/2) - \theta] \times (1-\cos\theta)\right\}$$

Since $\tan\theta = \sqrt{1-e^2}$ and the velocity ratio depends on e, the equation

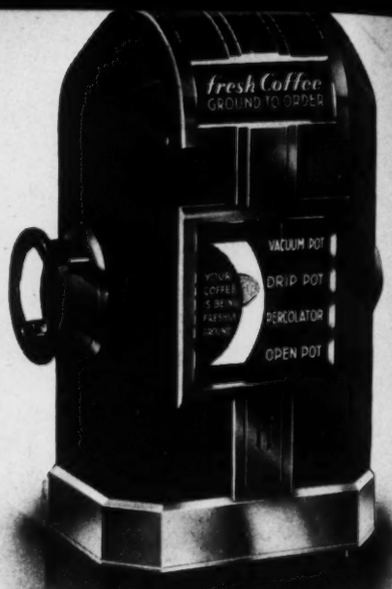
$$N.P. = aC$$

may be written where C denotes a constant appropriate to a particular maximum velocity ratio.

When a standard form of tooth is selected it is impossible to predetermine the shaft centers and velocity ratio by giving them both precise values. Either the center distance between shafts, or the velocity ratio involved in the constant C, must be subject to modification. The departure from preconceived values will be small. A modification of center distance amounting to about 0.01-inch will usually suffice to permit the use of a standard form of tooth, which is a desirable feature in manufacture.

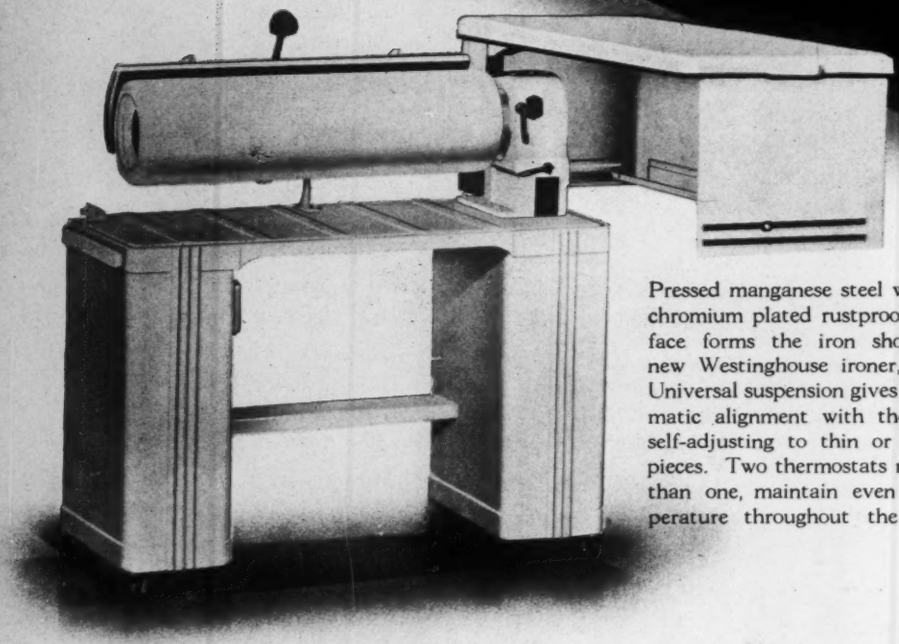


Designed with crinkle finish and with attention to appearance to attract favorable notice in the workshop, the Circle Ess flat-bit key duplicator, left, is also planned to provide easy operation. Micrometer adjustments, locking screws and switches are all available from a single position



Design e in New la

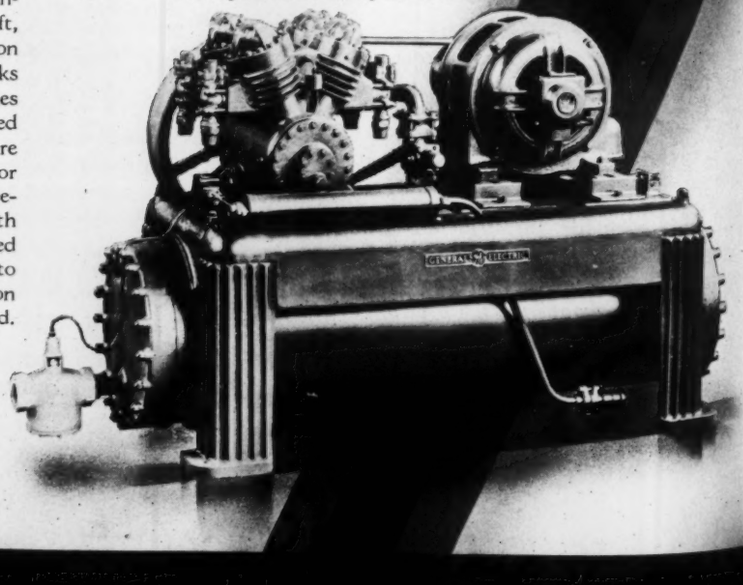
A Pictorial Presen of Be from the Si int



Pressed manganese steel with a chromium plated rustproof surface forms the iron shoe on new Westinghouse ironer, left. Universal suspension gives automatic alignment with the roll self-adjusting to thin or thick pieces. Two thermostats rather than one, maintain even temperature throughout the roll.

A V-type compressor of eight cylinders is used in new General Electric air conditioning refrigerating machine, below, which includes compressor, electric motor, and condensor all mounted in one compact unit. The unit is easily disassembled as all parts are readily accessible.

Homestead heavy-duty industrial cleaning unit, left, pumps water and solution from their respective tanks and automatically mixes them to a predetermined proportion while they are enroute to the generator coils. Velocity of the released spray combined with the reaction of the heated cleaning solution is used to break up the accumulation of material to be removed.



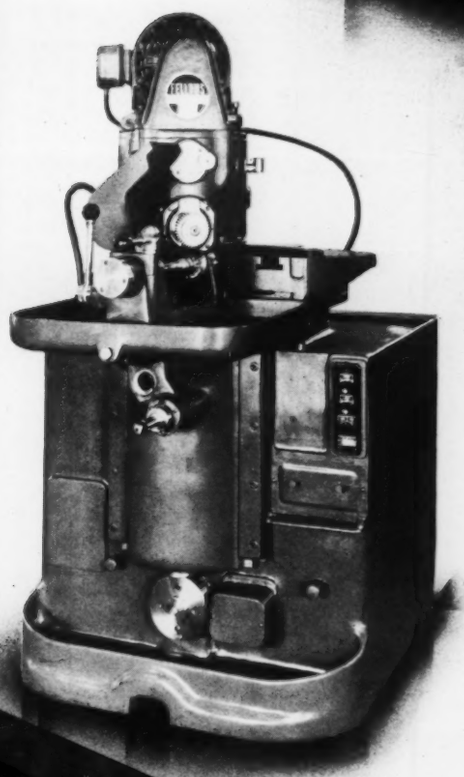
...ndwheel, turned ...point, automatic- ...t coffee mill, left, ...s ground to exact ... The black plastic ...idly supported, ...g surface is se- ...dimensional uni- ...ained by the use ... zinc alloy die

Careful balancing of parts, and use of light-weight material has made it possible to operate Katolight Jr. light plant without the necessity of bolting it down. Generator is driven by a four-cycle engine while speed is controlled by a mechanical governor. Intake and exhaust valves are mechanically operated.

An adding machine and a cash regist... are combined in Allen unit, abov... A trip on the top of the cash drawer ... operated by a plunger going through t... base of the machine, so that each tim... the adding machine handle is pulle... the drawer opens automatically.

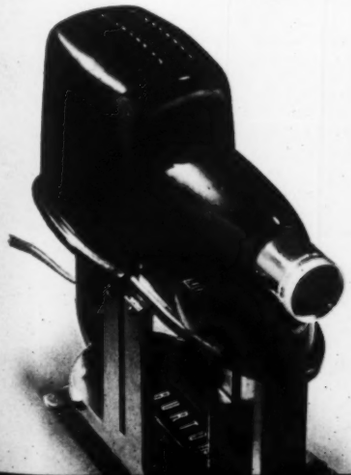
...n features ...w Machines

...ent... of Recent Machinery ... St...int of Design.

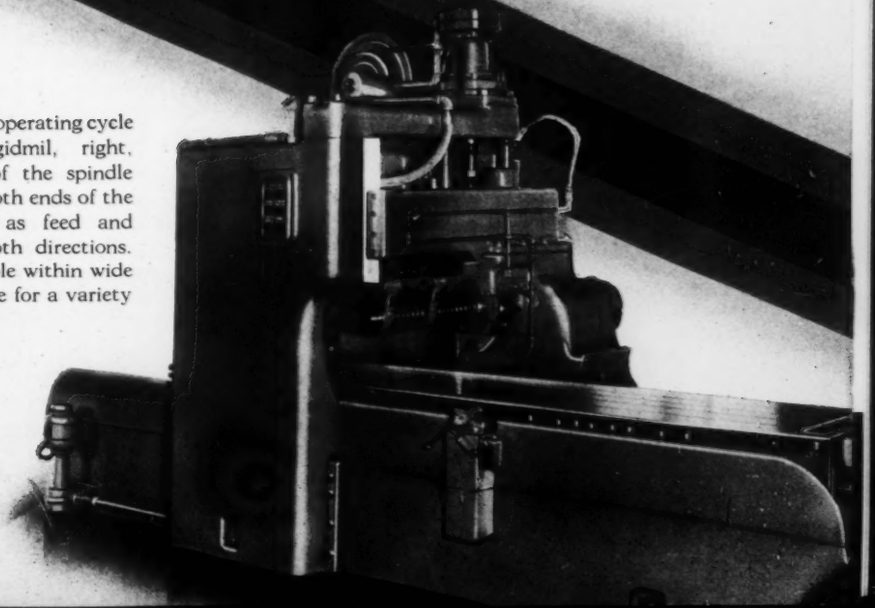


Enveloping generating tool of Fellow... gear generator, left, is kept in intima... contact with the work at the same tim... that it is being rotated at high spee... accompanied by a comparatively slo... reciprocating movement.

A fine achromatic lens with geared focusing device brings out minute details in Burton X-ray projector, below. For heat and electrical insulation, plastic molded parts are used in connection with chrome plated metal.



Automatic hydraulic operating cycle of Sundstrand Rigidmil, right, includes actuation of the spindle head and clamping both ends of the cross rail, as well as feed and rapid traverse in both directions. Dogs, easily adjustable within wide limits, fit the machine for a variety of work.



New Machines Indicate Design Trends

Design speeds design! Whenever distinctive innovations are announced in any field, every competing division in that field and every branch of the machinery building industry immediately speeds up design. This activity results in vastly improved machines, the urgent demand for new and improved materials, parts and processes. Every designer benefits, no matter how far removed may be his particular work. The interchange of design ideas, however, is a continuous process. The new watch may suggest an improvement in locomotives; the recent distinctive innovations in railroad motive power are certain to produce worthwhile changes in many, vastly different machines. Machines recently announced in addition to those on the preceding two pages include the following, arranged by fields of application.

Brewery

Semi-Automatic Labeler, Liquid Carbonic Corp., Chicago.

Construction

Vertical Turbine Pump, Worthington Pump & Machinery Corp., Harrison, N. J.

Squeeze Riveter, Hanna Engineering Works, Chicago.

Domestic

Air Stream Oil Burning Furnace, American Furnace Co., St. Louis.

Electric Generator, Johnson Motor Co., Waukegan, Ill.

Automatic Heating Plant, Anchor Stove & Range Co., New Albany, Ind.

Drink Mixer, Walter Watling Inc., Chicago.

Farm Washer, Altorfer Bros. Co., Peoria, Ill.

Food

Cleaner for Dry Materials, Jabez Burns & Son Inc., New York.

Sifter, Sprout, Waldron & Co. Inc., Muncy, Pa.

Industrial

Solvent Degreasing Machine, Detroit Rex Products, Detroit.

Pot Hardening Furnace, American Gas Furnace Co., Elizabeth, N. J.

Switching Locomotive, Euclid Road Machinery Co., Cleveland.

Metalworking

Camshaft Bushing Assembling Press, Oilgear Co., Milwaukee.

Power Squaring Shears, Niagara Machine & Tool Works, Buffalo, N. Y.

High Speed Vertical Miller and Profiler, Pratt & Whitney Division, Niles-Bement-Pond Co., Hartford, Conn.

Double Head Threading Machine, Acme Machine Co., Cleveland.

Sheet Buffing Machine, Divine Bros. Co., Utica, N. Y.

High Speed Automatic Die Casting Machine, Kux-Lohner Machine Co., Chicago.

Mining

Coal Cleaner, Wilmot Engineering Co., Hazelton, Pa.

Office

Direct Process Duplicator, Ditto Inc., Chicago.

Duplicators, Niagara Duplicator Co., San Francisco.

Duplicators, Universal Repro-Graph Co., Minneapolis.

Printing

Photo-Letter Composing Machine, Rutherford Machinery Co., New York.

Two-Color Offset Press, Miehle Printing Press & Mfg. Co., Chicago.

Textile

Bias Collarette and Strip Cutting Machine, J. A. Firsching, Utica, N. Y.

Cellophane Staple Cutter, F. J. Stokes Machine Co., Philadelphia.

Stainless Steel Dye Reel, Hinnekens Machine Co., Paterson, N. J.

Welding

Motor-Driven, Single Operator Type, Lincoln Electric Co., Cleveland.

Press Type Electric Resistance Machine, Eisler Engineering Co., Newark, N. J.

MACHINE DESIGN

Faster Production Means More Purchasing —and Increased Employment

ACCORDING to a recent estimate by Walter P. Chrysler, an automobile which today sells for $600 would cost at least $3500 if made by non-mass-production methods. This in itself is not startling, but much more significance attaches to the figures when it is considered that the number of cars sold during 1935 above the $3000 wholesale price range was 2428 as compared with about four million cars sold in all price ranges during the same period.

Such figures provide a powerful argument against those who still cling to the belief that machinery causes unemployment. Without equipment capable of producing cars at a price within the reach of the majority, the automobile industry would be a mere semblance of what it is today, with employment correspondingly low.

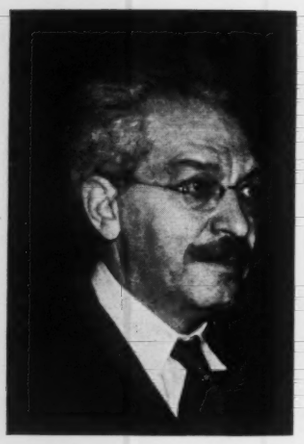
This is but one instance of the effect production by machinery has on providing work. It can be proved that practically every industry, particularly in the consumer goods class, is in the same category. Consequently the only conclusion is that, to put more people to work it is necessary to provide machines capable of producing even more goods at less cost and thus bring them within the purchasing range of more and more people.

Have You Tried It?

REGARDLESS of its merits or demerits in comparison with other machine-building processes, welding has come to stay as a tool of the designer. Its constantly growing application cannot but indicate its acceptance as the most promising method of modern construction. One fact in confirmation of this is that materials of design are no longer cataloged simply on their corrosion-resistant, heat-resistant or other properties—their "weldability" now is taken into full account.

Because of this specific interest in the welding art, and in view of requests from readers, MACHINE DESIGN has scheduled a special Welding Section for inclusion in the October issue. This is timed to appear just prior to the National Metal Show. It will throw considerable light on new ideas in welding which will be demonstrated at that exposition, as well as providing a valuable reference on the most up-to-date welding developments in the machine design field.

MEN of MACHINES



SOL EINSTEIN

SOL EINSTEIN, who was recently elected vice president of the Cincinnati Milling Machine Co., literally "started at the bottom" with that company in 1903—as a tracer. With continuing faith in his choice of mechanical engineering as a career, Mr. Einstein through ability and hard work advanced step by step through the grades of detailer and designer. He was appointed chief engineer of the company in 1920, and lately he has been devoting a large part of his attention to special engineering and patent matters.

Widely known and highly respected, Mr. Einstein frequently is invited to speak at technical meetings, particularly those of the American Society of Mechanical Engineers, in the affairs of which he has been active as a member since 1913.

• • •

W. C. STEVENS

WITH a wealth of experience both in engineering and in selling, W. C. Stevens, now vice president in charge of engineering, Cutler-Hammer Inc., believes in modern industrial styling. A native of Portland, Me., and a mechanical engineering graduate of Cornell university, Mr. Stevens joined the engineering department of what then was the Cutler Hammer Mfg. Co. in 1906. During his thirty years with the company he has served as sales and service engineer, special factory sales engineer, district sales manager in Chicago and New York, general sales manager, director of development and research, and chief engineer.

As a recognized authority on electrical control, Mr. Stevens has been closely associated with such projects as the Panama canal, Welland canal, Mississippi waterways and Boulder dam.

• • •

RUDOLPH FURRER

TWENTY-NINE years ago Rudolph Furrer began his mechanical career as an apprentice in the Scranton shops of Allis-Chalmers Mfg. Co. Today he is industrial engineer of the manufacturing department of that company at Milwaukee. His has been a life rich in practical experience. He was born at West Hoboken, N. J., in 1893 and gained his education through special studies. From the Allis-Chalmers shop he was transferred to the engineering department. There he became a draftsman and eventually a designer of hydraulic turbines.

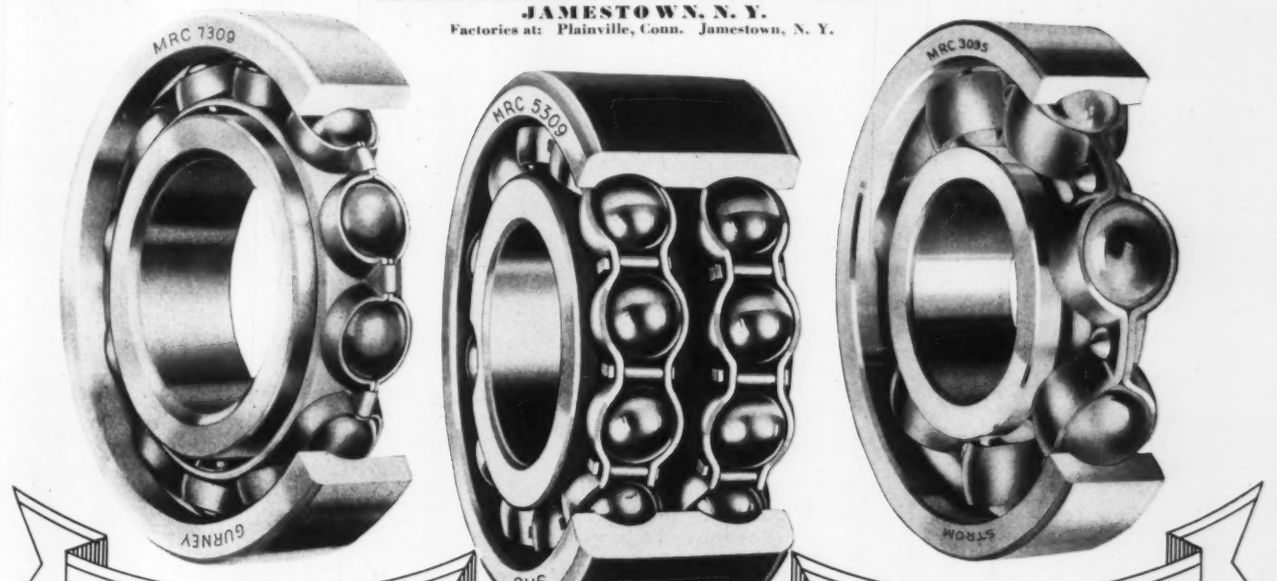
At the beginning of the year 1918 Mr. Furrer left Allis-Chalmers to become a machine designer with A. O. Smith Corp., Milwaukee, but the war intervened and in June he joined the Aviation Section, Naval Reserve, being in charge of machinery at the

LEADERSHIP

With a complete range of types and sizes, Marlin-Rockwell offers the engineer a line of stock bearings in which he will find the correct one for practically any load carrying requirement.

In addition, M-R-C field men are always available for consultation on specific problems.

MARLIN-ROCKWELL CORP.
JAMESTOWN, N. Y.
Factories at: Plainville, Conn. Jamestown, N. Y.



GURNEY *an* **M-R-C** *Bearing*

SRB *an* **M-R-C** *Bearing*

STROM *an* **M-R-C** *Bearing*

M-R-C Strom SRB GURNEY BALL BEARINGS

M-R-C *Ball Bearings*

GURNEY ● SRB ● STROM

M-R-C Strom SRB GURNEY BALL BEARINGS

Great Lakes training school. After the war, he was for a time hydraulic engineer with Wellman-Seaver-Morgan Co., Cleveland, but returned to the A. O. Smith organization in 1920. There he successively was designer, supervisor of machine construction, purchasing engineer, assistant to the works manager, and from 1927 to 1932 was chief engineer.

Between 1932 and his recent return to the company with which he began his career in 1907, Mr. Furrer was assistant to the vice presidents of the National Tube Co., making his headquarters in Pittsburgh. He is a member of the American Society of Mechanical Engineers.

♦ ♦ ♦

R. H. DAISLEY has been appointed assistant general manager, Wilcox-Rich Corp., Detroit. He has a background of many years of engineering and manufacturing experience with this company.

♦ ♦ ♦

V. FLETCHER HARPER, well-known metallurgist and past president of the American Society for Steel Treating, has resigned from the Allis-Chalmers Mfg. Co. to join Globe Union Mfg. Co., Milwaukee.

♦ ♦ ♦

R. KAREY has been appointed chief engineer, outboard motor division, Bendix Marine Products Co., South Bend, Ind. Mr. Karey, who is an authority on design of marine engines both of two-cycle and diesel type, was with Johnson Motor Co. for ten years.

♦ ♦ ♦

HARRY A. MILLER, noted designer of racing cars and engines, has been elected a vice president of American Bantam Car Co., Butler, Pa., successor to American Austin Co.

♦ ♦ ♦

NATHAN S. OSBORNE, physicist in the United States bureau of standards and international authority on compilation and standardization of steam tables, was awarded the honorary degree of Doctor of Engineering during the recent semicentennial reunion at Michigan College of Mining and Technology.

♦ ♦ ♦

HAROLD STEIN has been appointed research engineer in the manufacturing department of Allis-Chalmers Mfg. Co., Milwaukee. He has been with this company for twenty years.

♦ ♦ ♦

FRANK C. REED, long recognized as one of the leading engineers in the field of elevators, has been elected president of Westinghouse Electric Elevator Co.

♦ ♦ ♦

ALFRED IDDLES, vice president, United Engineers and Constructors Inc., Philadelphia, has been elected chairman of the mechanical standards committee, American Standards association.

♦ ♦ ♦

W. P. PICKHARDT, formerly president of Unyte Corp., New York, has been elected a director of Plaskon Co. Inc., into which the Unyte company has been merged. Other officers of the enlarged company remain the same as the former Plaskon company, with headquarters at Toledo.

♦ ♦ ♦

D. S. ELLIS has been appointed chief mechanical executive of Chesapeake & Ohio, New York, Chicago & St. Louis and Pere Marquette railways.

♦ ♦ ♦

F. H. HARDIN has been made president of the Association of Manufacturers of Chilled Car Wheels, with headquarters in Chicago. Mr. Hardin was formerly assistant to the president of the New York Central railroad and had charge of that company's mechanical departments.

CARL NYGREN has resigned from the Sullivan Machinery Co. to become chief engineer of Michiana Products Corp., Michigan City, Ind.

♦ ♦ ♦

OTTO JABELMANN has been appointed head of the bureau of research just established by the Union Pacific railroad at Omaha, Neb.

♦ ♦ ♦

T. J. MCDERMOTT, formerly chief draftsman, has been made mechanical engineer of the Delaware, Lackawanna & Western railroad, with headquarters at Scranton, Pa.

♦ ♦ ♦

DELMAR G. ROOS has resigned as vice president in charge of engineering, Studebaker Corp., South Bend, Ind. Mr. Roos, formerly chief engineer of Pierce-Arrow and later of Marmon, is a past president of the Society of Automotive Engineers.

♦ ♦ ♦

W. C. HEATH, formerly vice president in charge of manufacture and engineering, has been elected president of A. O. Smith Corp., Milwaukee.

♦ ♦ ♦

J. M. FLOYD has been made vice president in charge of manufacturing and engineering of A. O. Smith Corp., Milwaukee. Mr. Floyd, who has been active in the automotive industry for a quarter of a century, formerly was with Bendix Corp.

♦ ♦ ♦

C. D. ELLIOTT, well known as a consulting engineer, has been elected vice president of Billings & Spencer Co., Hartford, Conn.

♦ ♦ ♦

MORRIS E. LEEDS, president, Leeds & Northrup Co., Philadelphia, has been awarded the degree of Doctor of Engineering by the Polytechnic Institute of Brooklyn.

♦ ♦ ♦

ELIAS S. CORNELL has been appointed chief engineer of Delta-Star Electric Co., Chicago. Mr. Cornell, who received his degree in electrical engineering from the University of Zurich, Switzerland, joined the company in 1926 and had been assistant chief engineer since 1930.

♦ ♦ ♦

R. B. NICHOLS has been appointed manager of the industrial bearing division of Bantam Ball Bearing Co., South Bend, Ind. He formerly was factory superintendent and later manager of the Chicago office.

♦ ♦ ♦

F. AUSTIN DAVEY has resigned as chief engineer, Empire Sheet & Tin Plate Co., Mansfield, O.

♦ ♦ ♦

W. L. BADGER, professor at the University of Michigan, has been appointed a director of the consulting engineering division, Dow Chemical Co., Midland, Mich.

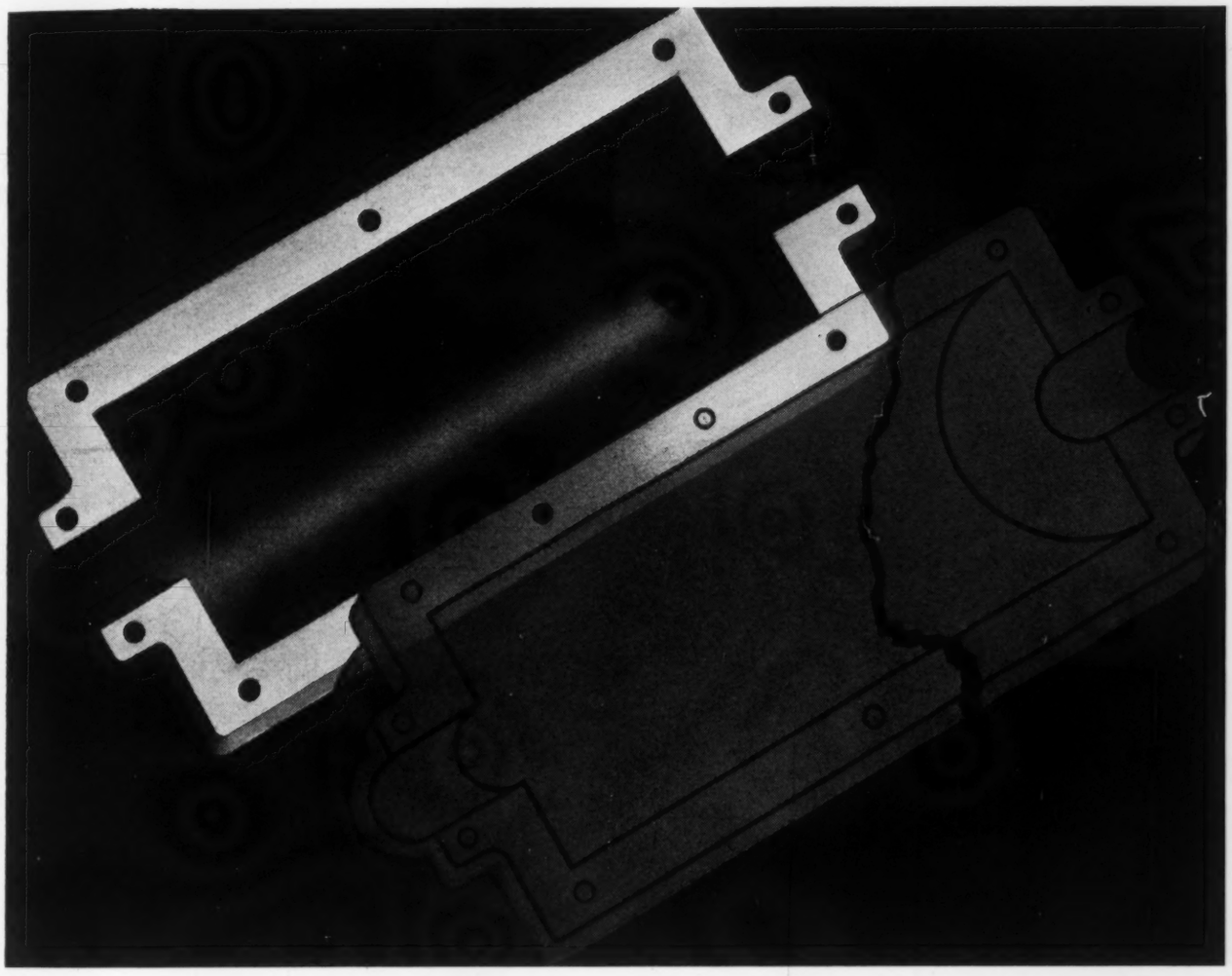
♦ ♦ ♦

A. R. ELLIS has been elected president of the Pittsburgh Testing Laboratories, Pittsburgh. He has been connected with the organization since 1905 and is an outstanding authority on engineering materials.

♦ ♦ ♦

LESTER BENSON, now factory manager, Bell Aircraft Corp., Buffalo, was incorrectly reported in the April issue of MACHINE DESIGN as being the designer of the Clipper Ships now flying the Pacific. Mr. Benson, who was not responsible for the incorrect statement, actually was superintendent of the Glenn L. Martin factory when the Clipper Ships were under construction there.

"At last! . . . and MOLY did it!"



WHERE is the foundryman who has not encountered difficulties with malleable-iron castings due to primary graphite—especially in parts where coring prevents rapid cooling of heavy sections?

A founder of housings for a piece of apparatus subject to high-pressure loads had such a problem. Coring was complicated and sections were heavy. Rejects were 100%.

The addition of .35% Moly corrected the trouble after everything else had failed. Rejects ceased. Moly not only made production possible, but made the castings even better than had been anticipated.

Your cast-iron problems may be different. They may involve matters of increased toughness, or resistance to heat, or merely the production of high-test iron. In any case, it will pay you to investigate Moly—"industry's most versatile alloy."

Our technical book, "Molybdenum," is full of practical information. Our periodical news-sheet, "The Moly Matrix," keeps you informed as to the latest developments in Moly irons and steels. They and the help of our experimental laboratory are yours for the asking. Climax Molybdenum Company, 500 Fifth Avenue, New York City.

MOLY

Mo-lyb-den-um

CUTS COSTS

CREATES SALES

Noteworthy Patents

HIGH pressure liquid in the inlet and outlet passages of rotary pumps of spur gear type sometimes has a tendency to cause localized strain and friction. To overcome this, William C. Sieverts, Quincy, Mass., has developed a design by which pressure is equalized through a system of bypasses. Details of this system, as covered by a patent recently issued are shown in *Fig.* 1, both two and three-gear designs being included in the illustration.

With reference to the two-gear type, inlet and outlet to casing *A* are designated by *B* and *C* respectively. The teeth (sometimes called "buckets") of impeller gears *D* and *E* are of the type ordinarily employed in rotary gear pumps and hydraulic motors. One of the gears runs on a stud while the other is mounted on a driving shaft.

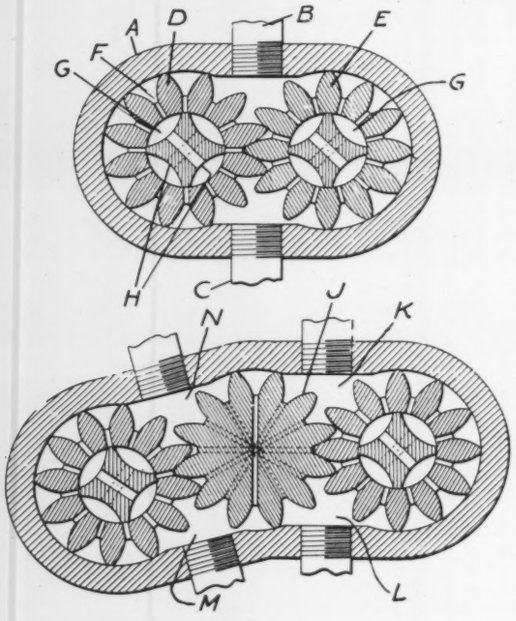


Fig. 1—*Geared rotary pumps designed to relieve built up pressure caused by liquid flow*

Unlike those in the conventional pump or hydraulic motor, however, these gears are provided with ducts, as shown by reference letter *F*, and both stud and drive shaft are recessed as indicated by *G*. The passages marked *H* give free outlet to liquid which is forced through ducts *F*, thereby relieving what otherwise would be localized built-up pressure.

The design of the three-gear type, also shown in *Fig.* 1, is similar to that of the two-gear type. The principal difference is that an intermediate gear *J* is introduced between the drive and stud gears. As will be noted, if the action of this gear train be analyzed, *K* and *M* are inlet chambers, while *L* and *N* are outlet chambers, assuming the drive to be in counterclockwise direction. In this case the conduits from the dual inlet and outlet chambers either can lead from and to a common source and discharge, or the assembly can be employed as two pumps, each with its independent inlet and outlet.

This patent is designated as No. 2,029,742.

USE of a flexible stop to limit the expansion movement of a thermostat bellows is a feature in a patent granted to Marshall H. Ward, assignor to Bridgeport Brass Co.

Fig. 2 is a longitudinal section through the

The World's Largest Automobile Body Presses Operate on Timken Bearings

The automotive industry has probably been responsible for more revolutionary developments in production machinery than any other.

Machine manufacturers have cooperated closely with car manufacturers in bringing out new machines to meet their demands for precision, speed and economy. When the idea for the one-piece steel top was evolved, it brought with it the necessity for larger, more powerful body presses than had ever been known before.

Four of these mammoth presses—the world's largest—are shown in the above photograph. These are Hamilton presses built by The Hooven, Owens, Rentschler Co., Detroit.

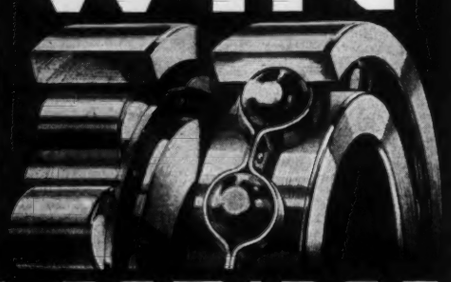
Timken Bearings are used in all of these presses. The drive shaft rotates on Timkens, likewise the clutch and flywheel units.

The exclusive combination of Timken tapered construction, Timken positively aligned rolls and Timken Alloy Steel meets every requirement in friction elimination; accuracy; radial, thrust and combined load capacity; and the holding of moving parts in correct and constant alignment. It will pay you to have Timken Bearings in your equipment.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN *TAPERED ROLLER* BEARINGS

TWIN PRECISION



IN the past 20-odd years many standards have become flexible, and quality has—in many cases—become a variable thing . . . But throughout this period NORMA-HOFFMANN Precision Bearings have been consistently made to the highest standard of excellence . . . They continue to be the choice of those who measure value by service rendered, and who seek the lowest cost per bearing per year of useful life . . . *Write for the Catalog. Let our engineers work with you. . . . . .*

"NORMA-HOFFMANN"
PRECISION BEARINGS
BALL, ROLLER AND THRUST
NORMA-HOFFMANN BEARINGS CORPORATION,
STAMFORD, CONN., U. S. A.

mechanism, with the bellows in expanded condition. In this diagram, *A* is a fixed base to the flange of which the stationary end of the bellows is soldered. The outer, or movable end of the bellows is sealed by a member *B* of which the point *C* in this case may serve as part of a valve or may serve to make and break an electrical circuit.

The inner end of member *B* is a cup *D* which is closed loosely around the terminal bead of bead chain *E*. The other end of this chain is held in a slot in crowned washer *F*. With conditions as shown in *Fig.* 2, the chain is serving to prevent point *C* of member *B* from moving outward any further, thereby preventing undue pressure on the point and undue stretching of the bellows in case the pressure within the bellows should continue to rise. At the same time any necessary lateral displacement or twisting of the bellows in no way is interfered with.

When the bellows collapses, the bead chain is accommodated in the pocket formed by the extension of base *A* within the bellows. The end of this extension, by contacting the close

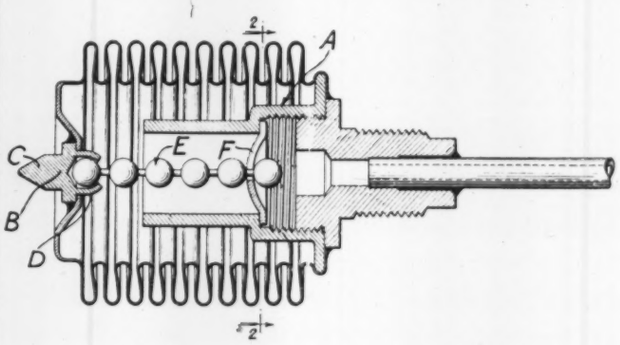


Fig. 2—Bead chain serves to prevent undue stretching of metallic bellows used on pressure controls

end of the bellows, limits its collapsing movement to a safe amount. The construction shown in the diagram is adapted for use with refrigerator control switches.

The inventor points out that bellows of this type are usually filled with gas or operate through filling with gas under pressure. Unless restraining means is provided, damage to the bellows is liable to occur. At the same time restraint should in no way interfere with free and frictionless operation of the bellows as a thermostat. The arrangement shown takes care of the requirements with a simple and compact connecting means.

This patent is identified by No. 2,031,440.

MOST mechanical vibratory systems are proportioned so that they resonate within the frequency range over which they are intended to be used. Henry C. Harrison, Port Washing-

• ALERT ENGINEERS SOLVED A PROBLEM

Improved the Differential Drives on Roller Mill Equipment

DRIVE FOR DIFFERENTIAL SIDE

The differential (the slow side) drive of two or three pair high mills has always been a problem. Formerly either pulleys or gears were used — both were objectionable. With the pulleys, the attendant expense of belts and tighteners raised the danger of open belts, or the expense of guarding them. With gears there was undue noise, with the necessity and expense of having the gears recut when rolls needed to be recorrugated and the fact that the rolls had to be reground to exact dimensions even though quite a bit of roll chill was removed.

With the development of the silent roller chain Allis-Chalmers originated a way to utilize this very satisfactory method of driving the differential side. It is more costly to equip a mill in this manner than with pulleys or gears, but the silence and efficiency of the roller chain drive operating in an oil tight case justifies the expense and again proves the alertness of Allis-Chalmers engineers. The roller chain differential drive is without a doubt the outstanding improvement within recent years on mills of this type.

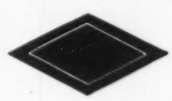
* *Reproduced from the Mill Machinery Manufacturers' Bulletin.*

Diamond Roller Chain on roller mill (case cover removed)—3" pitch double-strand chain—sprockets of 22, 31, 46 and 55 teeth to provide the shaft speeds and speed differentials desired.

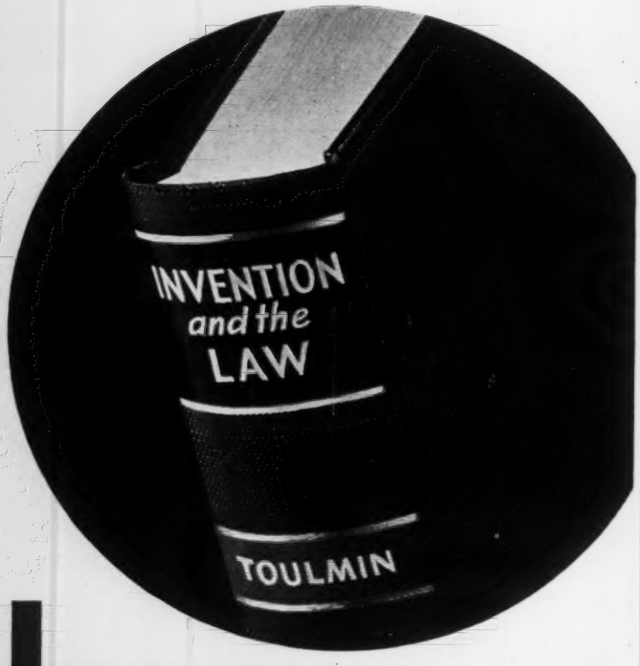
Malt mill equipped with 1" pitch double-strand Diamond Chain with sprockets of 25 and 55 teeth.

The Chain Used is DIAMOND

Similar product improvement is going on continually under the direction of alert engineers in every field—and the adaptations and applications of Diamond Roller Chains are continually widening . . . To those who have drive problems of any kind the service and recommendations of our engineers are gladly offered. Catalog on request. DIAMOND CHAIN & MFG. CO., 435 Kentucky Ave., Indianapolis, Ind. *Offices and Distributors in Principal Cities.*

This Trade Mark  *On Every Link*

DIAMOND ROLLER CHAIN



INVENTION and the LAW

Harry Aubrey Toulmin, Jr.

J. D., Litt. D., LL. D.
Member A. S. M. E., Franklin Institute, S. A. E., etc.

HERE is a much-needed, practical manual on patentable invention for the use of engineers and executives, as well as for attorneys, by a writer experienced in this field. It is a complete desk manual on how to determine invention.

What is Design that is not Invention? What is Invention? This new book enables you to find quickly a clear and understandable statement of the RULES on each invention question. These rules are based upon decisions of the Supreme Court of the United States. They are accurately stated in simple and understandable language for engineers and executives.

This book answers questions as to how invention is determined; explains invention rules in other countries; what you must do to determine the patentability of inventions. It contains exhaustive indexes of every rule involving invention with a complete list of books and magazine articles in English, French and German on invention.

You may order *Invention and the Law* for five days free approval. At the end of that time, return the book to us, or remit $5.00. 347 Pages, 6 x 9 inches.

PRENTICE-HALL, Inc.
Dept. IP-19 70 Fifth Ave.
New York, N. Y.

ton, N. Y., has overcome this shortcoming by a method covered by a patent assigned to Bell Telephone Laboratories Inc., New York.

In the Harrison device dampening is applied in such a way as to be effective only in that portion of the range in which resonance occurs. This is accomplished by using an extremely "dead" dampening material such as a disk or thin block of reclaimed rubber. This is attached at its center to a vibrating system but is left free at its periphery so that it will vibrate bodily as a mass for low frequencies.

The reproducer shown in *Fig.* 3 is of the moving coil type. Coil *A* is vibrated in annual air gap *B* by stylus *C* as it follows the vertical undulations of record *D*. Magnetic flux for the air gap is provided by magnet *E* whose poles are connected with central pole piece *F* and the pole

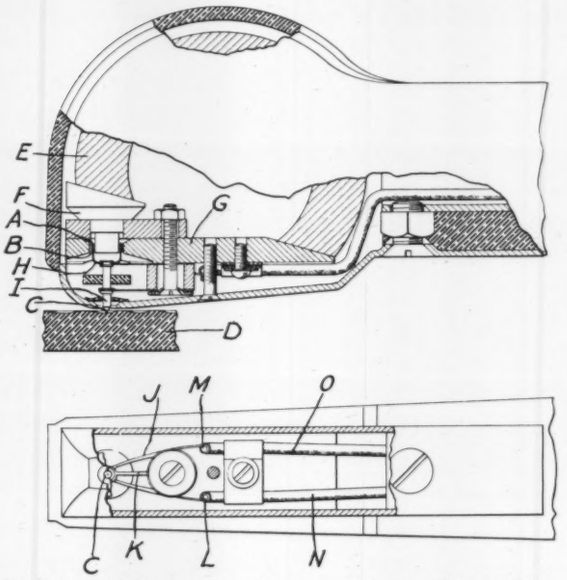


Fig. 3—Details of an arrangement for dampening vibrations of the moving systems of phonograph reproducers

G which together define the gap *B*. Coil *A* is mounted on cup-shaped member *H* which is connected to the stylus by tubular member *I*. The vibrating system comprising coil, stylus and members *H* and *I*, is supported elastically by upper and lower springs, *J* and *K*. As can be seen in the bottom view in *Fig.* 4, the lower part is a single narrow spring, whereas the upper spring *J* is V-shaped. With this form of construction stylus *C* is free enough laterally so as readily to follow slight irregularities of the record groove. Coil *A*, however, is restrained from lateral movement by the gap in the upper spring *J*. The ends of the winding on coil *A* are brought out to binding posts, *L* and *M*, from which connections are made to an external circuit through conductors *N* and *O*, on the reproducer arm.

The number of this patent is 2,031,948.

OLD timers know "SHELBY" from 'way back — and they still swear by it. Their preference for this Seamless Tubing of a thousand uses is not based on hearsay, but on hard practical experience. They know that long before mechanical tubing as such became generally known, SHELBY led the field — pioneered its use in the many applications in which seamless mechanical tubing today is accepted as not only the most practical but the most economical form to use steel.

As made today by the largest manufacturer of tubular products in the world—SHELBY Seamless still carries on the high tradition of its early beginnings. It is still tops in mechanical tubing — for in its production are combined the experience of thousands of craftsmen, skilled in tube making, jealously safe-guarding the name "SHELBY," determined that it shall be borne only by the best tubing made.

SHELBY Seamless—round, square, oval, rectangular, etc.—is available in practically any size and wall thickness, in grades and treatments of steel of wide variety. If you make parts or "articles" try it out in your shop, find out how easily it fabricates—how it minimizes grinding and machining operations, cuts tool costs, reduces labor.

Let our engineers show you how this versatile material can best be applied to improve production.

NATIONAL TUBE COMPANY

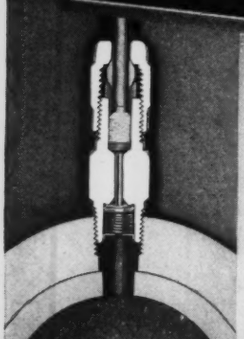
PITTSBURGH, PA.

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL

ACCURACY INSURED
...AT TOP SPEED

"Barber-Colman" Hobbing Machine



The correct oil film to each individual bearing... automatically

● Back a few years, you might have had cause to worry. But now, machines are equipped with the BIJUR automatic lubricating system. The correct oil film is maintained in each bearing . . continuously . . automatically. With BIJUR built-in lubrication, your mind is free. Lubrication troubles automatically dismissed!

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BIJUR
AUTOMATICALLY Correct LUBRICATION

Refrigeration Reaches Wrapping Machinery!

(*Concluded from Page* 24)

chanical damage to the insulation. The two side tanks are mounted on brackets, assembled on right and left-hand thread screws so that the tanks can be simultaneously moved to accommodate loaves of different lengths, range of adjustment being from a minimum length loaf of 7 inches to a maximum of 16 inches long. This adjustability requires flexible connections between the side cooling tanks and the main brine reservoir, and is accomplished by rubber tubing having a ½-inch inside diameter with a 1½-inch outside diameter. The covering is made of a special type of sponge rubber which does not absorb moisture. In operation with brine at a temperature of 13 to 17 degrees there has been no condensation on the outside of the rubber insulation even with room temperatures over 100 degrees.

Conveying Belts Transport Loaf

Two belts convey the package through the sealing zone. When the loaf of bread leaves the heaters, it is delivered on to a bottom conveying belt. To this arrangement a top conveying belt has been added so that the loaf is contacted on both the top and bottom by belts which are moving at the same speed and which convey the loaf through the side cooling zone. These two belts deliver the loaf after the ends have been cooled on to a bottom sealing tank where the loaf rests. The succeeding loaf pushes the first one off the bottom sealing tank on to the delivery table. There is no conveying mechanism that moves the loaf over the bottom sealing tank, but, as just stated, the action depends on one loaf pushing another. This bottom sealing tank is located at the end of the bottom belt.

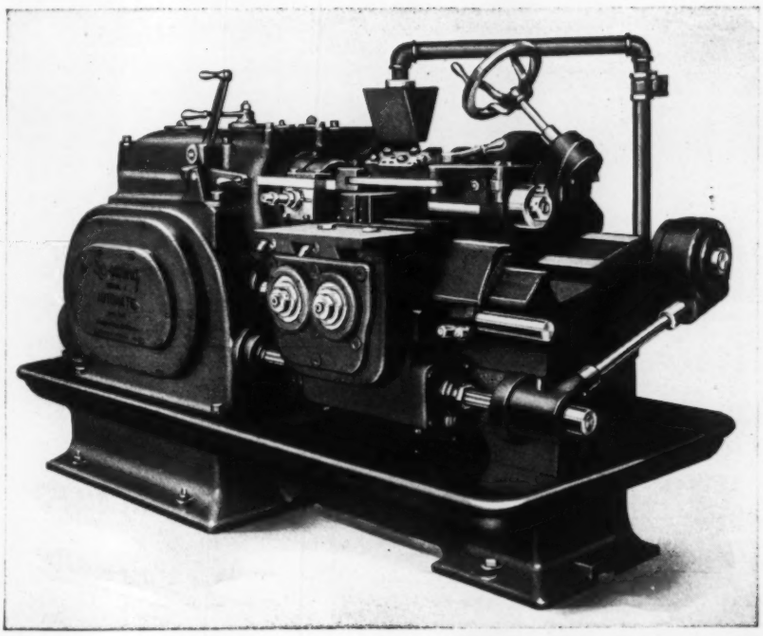
Standard refrigeration assembly practice has been used in that all parts are carefully dehydrated under a vacuum in an electric oven thermostatically controlled for a period of several hours. Extreme care is taken to prevent any dirt, moisture or air remaining in the refrigerating assembly and consequently no serious troubles have developed. The entire sealing unit is completely assembled in the shop, charged with the refrigerant and shipped to the customer so that no refrigeration connections are necessary at the time of installation.

In bakeries, it is common practice to cool bread in the wrapping machine room by means of either traveling conveyors or placing the bread on racks. The bread in cooling gives off a heat to the wrapping room air, and consequently higher temperatures can be expected than those outside of the bakery.

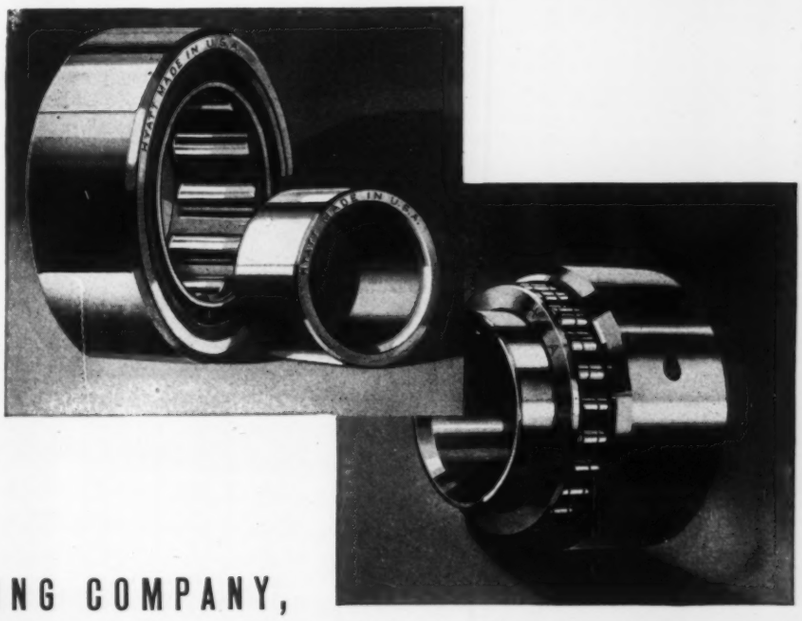
When it's a PRECISION *job..*

it's a job for

HYATT ACCURACY



By virtue of the scope of its resources, the skill of its technicians, the profit of its experience, Hyatt produces the finest roller bearings. Bearings that endure the merciless punishment of speed, stress, and shock without perceptible wear. Bearings that defy the imagination in their matchless perfection. Quiet bearings that keep related parts in permanent alignment. Bearings that serve longer and more efficiently, with the minimum of maintenance.



LO-SWING LATHES, a product of the Seneca Falls Machine Co. of Seneca Falls, N. Y., need no introduction when it comes to accuracy of work and dependability of operation. Hyatt Roller Bearings are an important part of their quality construction and a generous contributor to their fine performance. Another machine tool builder who for years has recognized how well Hyatts save and serve.

HYATT ROLLER BEARING COMPANY,

NEWARK, DETROIT, CHICAGO, PITTSBURGH, SAN FRANCISCO. IN EUROPE, 111 GROSVENOR ROAD, LONDON, S. W. 1.

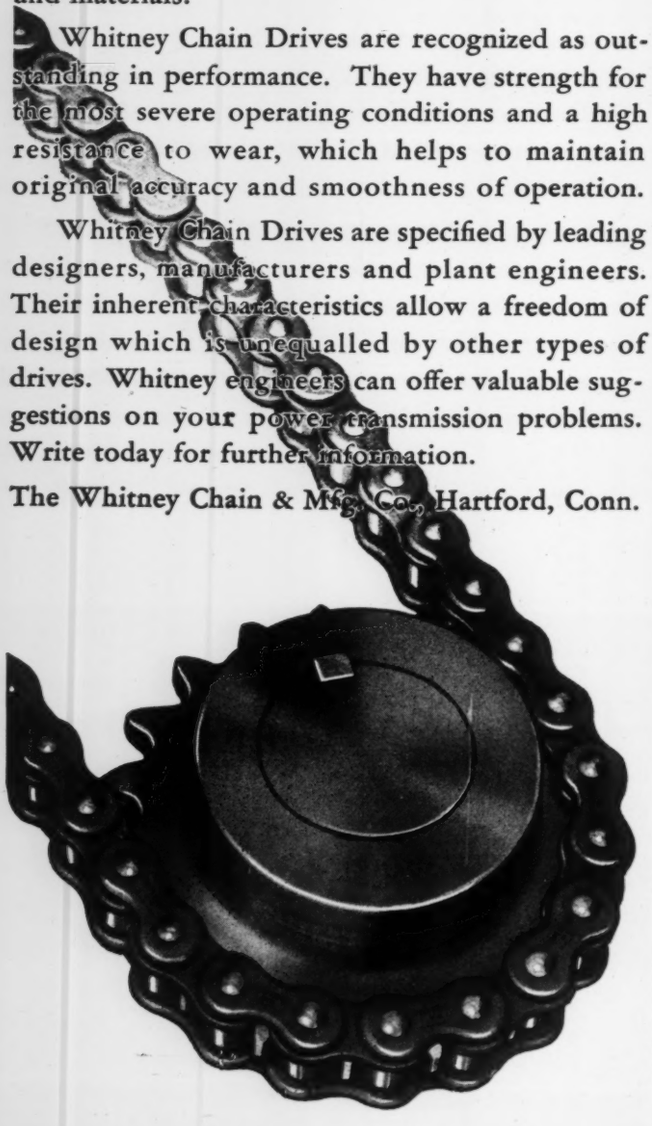
for MACHINE *Performance specify* MODERN *Chain Drives*

Chain drives gain increasing acceptance year by year as a means to profitable machine performance. The field of application for this positive and efficient power transmission medium has constantly widened, because modern chain drives have kept in step with improved manufacturing methods and materials.

Whitney Chain Drives are recognized as outstanding in performance. They have strength for the most severe operating conditions and a high resistance to wear, which helps to maintain original accuracy and smoothness of operation.

Whitney Chain Drives are specified by leading designers, manufacturers and plant engineers. Their inherent characteristics allow a freedom of design which is unequalled by other types of drives. Whitney engineers can offer valuable suggestions on your power transmission problems. Write today for further information.

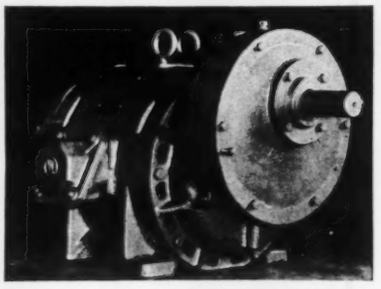
The Whitney Chain & Mfg. Co., Hartford, Conn.



NEW *Materials and Parts*

Gearmotors Are Explosion-Proof

SINGLE reduction explosion-proof gearmotors ranging in size from 1½ to 75 horsepower have been brought out in a new line by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Built to carry the maximum torque the motors will develop, gears of the units, shown herewith, are of the single helical type, heat treated by a special "tough hard" process to provide maximum load-carrying capacity and utmost resistance to wear and shock. Antifriction bearings are employed. The units are compactly built for application in Class 1, Group D hazardous locations, and are approved by the National Board of Fire Underwriters.



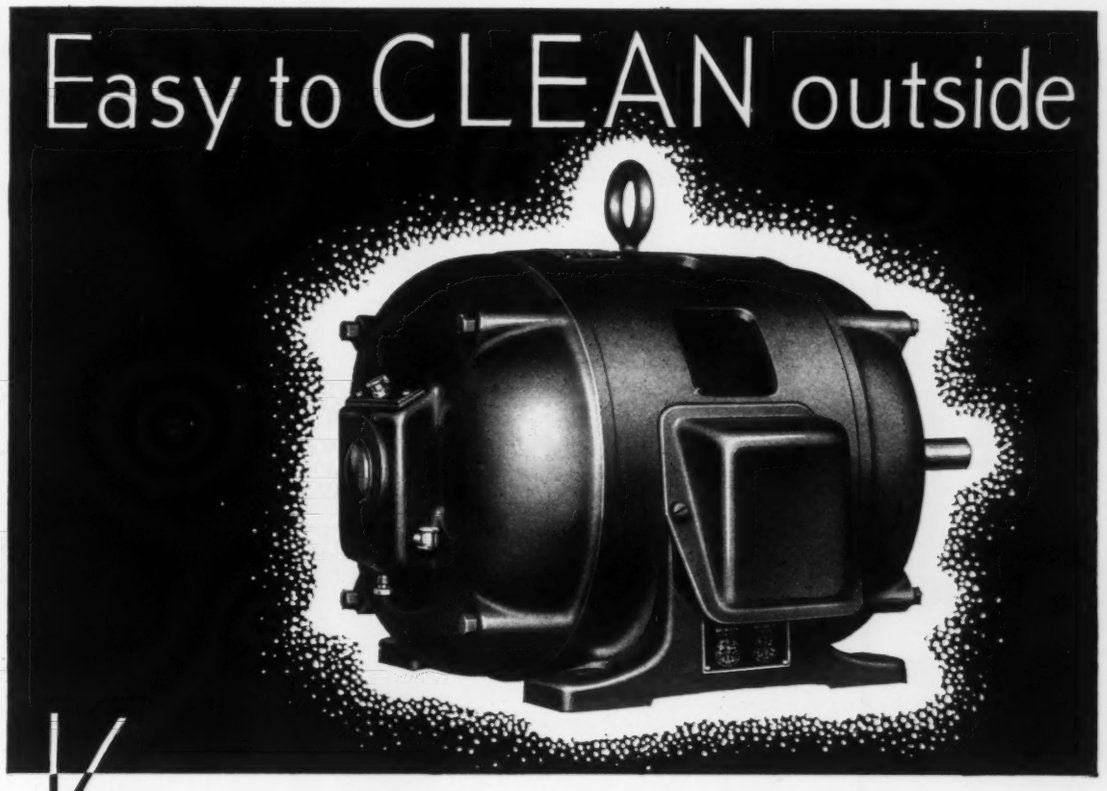
Intended for use in hazardous atmospheres, these gearmotors are explosion - proof

They are intended for use in hazardous atmospheres containing gasoline vapors and other gases or vapors having equivalent or less hazard such as petroleum products, ethyl alcohol, methyl alcohol, acetone, and lacquers, solvent vapors. Also, they are for use in dry cleaning and dry dyeing plants, pyroxylin plastic manufacturing plants, spray painting establishments, gas plants, varnish manufacturing plants and similar establishments.

Process Prevents Corrosion

BONDERITE "Z", a new process which prevents corrosion and stabilizes paint finishes on zinc-alloy die castings and galvanized and galvanealed iron has been announced by Parker Rust-Proof Co., Detroit. Technically, this is a chemical conversion process. It converts the

Easy to CLEAN outside



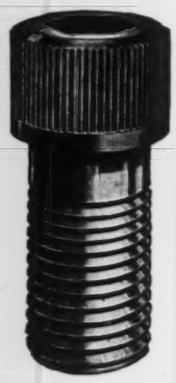
Keep Themselves Clean INSIDE

Century Polyphase Motors keep themselves clean inside in the presence of dust that will not harden with heat nor solidify with high humidity.... They are easy to keep clean outside ... They start quietly—run quietly—and are remarkably free from vibration.

CENTURY ELECTRIC COMPANY
1806 Pine Street St. Louis, Mo.
Offices and Stock Points in Principal Cities

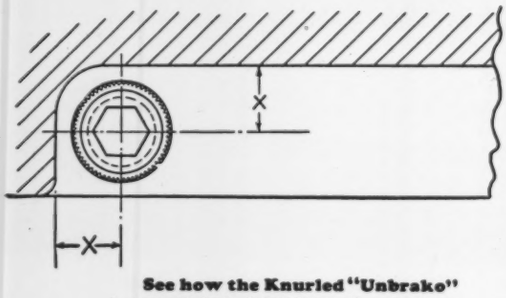
Century MOTORS

SIZES UP TO 600 HORSE POWER

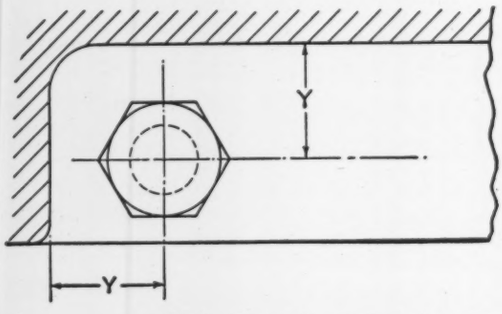


PATS. PENDING.
KNURLED "UNBRAKO"
SOCKET CAP

KNURLED UNBRAKO for COMPACT DESIGNS



See how the Knurled "Unbrako" snuggles right into the corner.



Notice the great open spaces necessary for the hex-head and wrench.

The difference between "X" and "Y" in line cuts demonstrates the decided saving in Clearance, Material, Weight and Cost made possible by using the Knurled "Unbrako" Socket Head Cap Screw.

Don't pooh! pooh! these advantages as they may help to make difficult designs easier and much more compact.

The Knurled "Unbrako" is the only Socket Cap Screw with a Knurled head; furthermore, the only one that can be locked and that will save time in assembling.

Be sure to get our complete and interesting "Unbrako" Bulletin No. 485.

Manufactured by

STANDARD PRESSED STEEL CO.

JENKINTOWN, PA.

Branch Offices and Warehouses

BOSTON ST. LOUIS
DETROIT CHICAGO
INDIANAPOLIS SAN FRANCISCO
Box 102

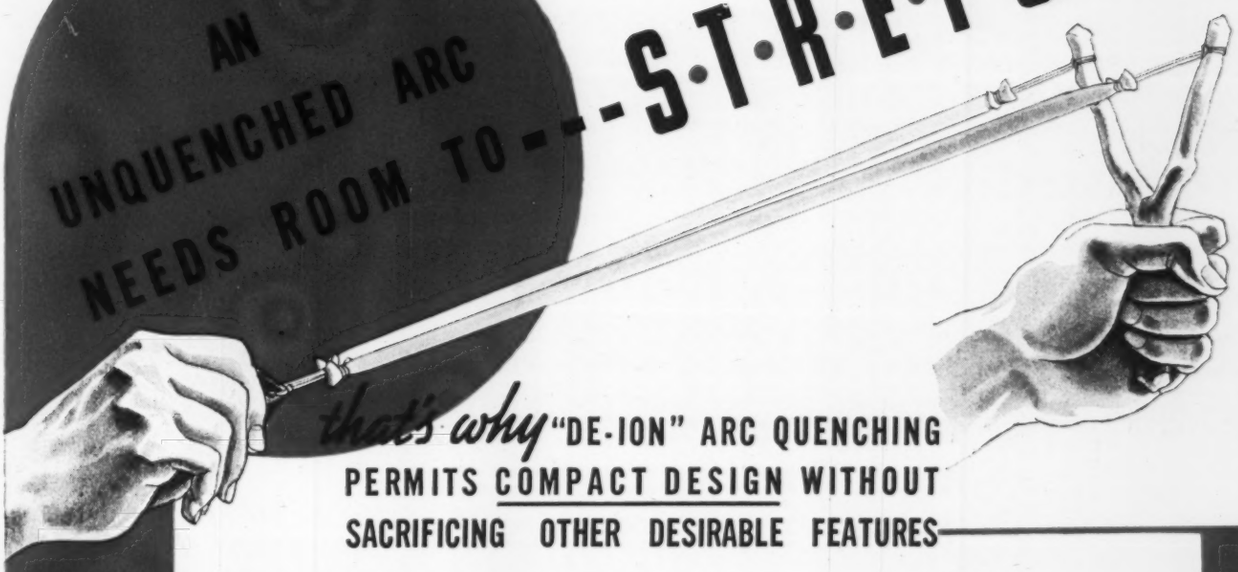
metal's smooth surface into an absorbent, paint-holding, crystalline structure and produces an insoluble phosphate coating that becomes an integral part of the metal itself. It may be applied to zinc-alloy die castings, stampings, forgings, and rolled or machined parts and galvanized or galvanealed parts of any size or shape. Recesses, depressions or internal threads do not effect the efficiency of the process. Parts to be treated are simply cleaned, immersed in the processing tank one-half to three minutes, removed, rinsed and dried. As the solution is applied at comparatively low temperatures, the size, shape or contour of the parts are not changed, and there is no distortion or warping.

New Filter Is Self-Cleaning

A NEW industrial filter, described as self-cleaning by a positive method which allows no accumulation of sediment, has been introduced by Motor Improvements Inc., 365 Frelinghuysen avenue, Newark, N. J. The filtering element in this unit, shown herewith, is submerged in the coolant in any container provided by the user. A motor-driven impeller type coolant pump in a housing inside the filtering element draws the coolant through the interstices of the filtering element and up through the pump housing to the work being ground or cut. As the coolant passes through the housing it strikes against vanes that rotate the filtering element. Also, a part of the coolant stream is diverted and forced under pressure into a vertical tube attached to the pump housing. This tube has a narrow slot extending its length. Filtered coolant rushes from the slot and through the

The liquid being filtered is employed in a unique arrangement to guarantee automatic self-cleaning of the unit

AN UNQUENCHED ARC NEEDS ROOM TO---S·T·R·E·T·C·H



that's why "DE-ION" ARC QUENCHING PERMITS COMPACT DESIGN WITHOUT SACRIFICING OTHER DESIRABLE FEATURES

The exclusive "De-ion" Arc Quencher on all new Westinghouse Linestarters permits compact design, with mechanisms and enclosures to fit the most rigid space requirements. Ease of installation is remarkable, and accessibility of every part from the front simplifies maintenance and inspection. You get all these and many other advantages in Westinghouse Linestarters alone, and the new line is complete, with a size and type for every requirement. J 20041

For complete details call your nearest:
WESTINGHOUSE OFFICE WESTINGHOUSE JOBBER
WESTINGHOUSE INDUSTRIAL AGENT

SUPER-SAFETY!

No flash or flame—the arc is snuffed out instantly by the "De-ion" Arc Quencher. This means elimination of flashover, assuring safety for operators.

LONG LIFE!

Instantaneous "De-ion" arc quenching means no pitted contacts—practically unlimited contact life. Simple mechanism with fewer parts.

RELIABILITY!

The "De-ion" arc quencher confines, divides and extinguishes the arc without the usual flash and flame—insuring freedom from flashovers, high overload capacity and dependable, trouble-free operation.

Westinghouse

"DE-ION" LINESTARTER

WESTINGHOUSE 1886 W 1936 GOLDEN JUBILEE

HERE'S HOW IT WORKS

In the past, arcs have been broken by "stretching." The "De-ion" quencher confines, divides and extinguishes arcs instantly — obviously preventing concentration of burning heat on contacts or arc barriers.

THE OLD WAY

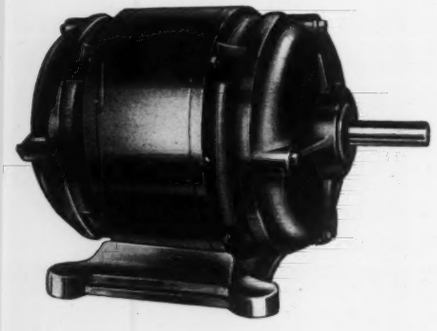
THE "DE-ION" WAY

Valley

incorporated BALL BEARINGS

in their *Design*

more than 20 years ago



Valley Electric Motors have been selected by many prominent design engineers because of these five salient features:

1 NO DEAD SPOTS: The careful design of Valley Ball-Bearing Motors has eliminated occurrence of "dead spots."

2 EFFICIENT AND VENTILATED WINDING: The Valley Short Throw Winding, together with the form-wound coils are used, and result in high efficiency and low heating.

3 40°C. MAXIMUM TEMPERATURE RISE: Valley Motors are rated 40°C. maximum temperature rise under continuous full load conditions. In actual service, their performance is much better than this rating.

4 SQUIRREL-CAGE WELDED ROTOR: All Valley squirrel-cage rotors are welded by a special pre-heating process insuring a perfect union of bar and end-ring.

5 BALL BEARINGS: All Valley Motors are equipped with ball bearings especially selected for their suitability for motor applications. These bearings are protected by oil seals, and are absolutely dust-proof.

Ball-Bearing Motors ¼ h.p. to 40 h.p.

VALLEY ELECTRIC CORP.

4221-27 Forest Park Blvd.
ST. LOUIS, MO.

interstices of the filter in reverse direction to the suction flow induced by the impeller pump. The filtering slots opposite this stream are thus cleaned of all sediment and as the rotation of the element brings each part of the surface successively opposite the slot, the entire filter is thus kept clean. Other vertical fins on the inside of the filtering element prevent the coolant from swirling.

The use of the liquid for rotating the filtering element enables rotation at the exact speed required and considerably slower than the pump so that the correct cleaning action is obtained. While designed primarily for machine shop use, the filter can, of course, be used in any application where a comparatively large continuous flow of clean liquid must be maintained.

Reducers Employ Special Gears

STANDARD Cone worm speed reducers ranging in centers from 4 to 18 inches and incorporating the usual types of mounting such as horizontal shafts, vertical gear shafts, worm on bottom, worm on top and combination helical worm gear units for high ratios of reduction are

New series of reduction unit employs worm gears of the Cone type in various arrangements

now being manufactured by Dominion Engineering Co. Ltd., Montreal, Canada. It is claimed that the use of the Cone type of worm produces reduction units which are lighter, more compact and more efficient when considering the horsepower transmitted.

The casing and covers of the units, shown herewith, are of cast iron construction, the integral wormshaft of a heat-treated alloy steel, and the worm gear of chill cast SAE 65 bronze.

● The heavier cuts made possible by modern machine tools result in important reductions in fabricating costs. But if it were not for Nickel Cast Iron, the frames, beds and ways of these machines would not have the strength and rigidity to stand the increased stresses and strains and still maintain accuracy.

Through a partnership with Nickel, plain cast iron acquires a denser grain structure and becomes harder, stronger . . . more highly resistant to stress, heat, pressure, wear and abrasion. Not only in machine tools but in scores of other applications, these improved properties will effect worthwhile savings in operating and upkeep cost.

Our experience in the application of Nickel to industrial problems is at your disposal. Send for List "A" of available publications on Nickel and its alloys.

Nickel Cast Irons

THE INTERNATIONAL NICKEL COMPANY, INC.
NEW YORK, N. Y.

MOTORPUMPS *give* ***Flexibility*** —

Vertical Mounting may be *your* solution . . . for a compact, self-contained, efficient rotary geared pump installation. But we can supply the **horizontal** mounting as well — an increasingly popular type. May we send details? Ask for Nos. 101 — 102 — 103 ROTARY GEARED MOTORPUMPS

Brown & Sharpe Mfg. Co.
Providence, R. I.

BROWN & SHARPE PUMPS

B·S

As a Blotter Absorbs Ink

Put your production machinery on FELT. Put your office appliances on FELT. Put your product on FELT; and put FELT into your product! Use FELT—engineered to the job by *Felters*—wherever sound is to be silenced; lubricants to be retained; dirt excluded; vibration cushioned; surfaces protected.

Mail the coupon for two interesting books on FELT; no charge or obligation.

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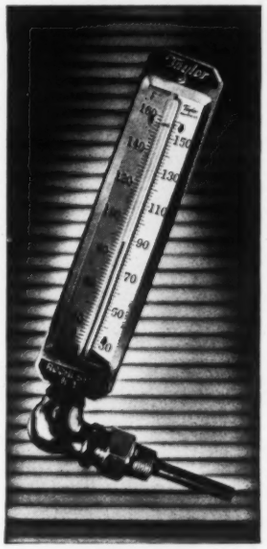
In the smaller units the gear is cast solid, but in the larger ones the gear is of the ring type fitted to a cast center piece. An auxiliary casing attached to the input side of a standard unit houses a pair of primary helical gears. The pinion is cut integrally on the input shaft and the gear is keyed on the worm shaft.

Thermometer Readability Improved

READABILITY of mercury-in-glass thermometers has been improved by a new thermometer tubing, known as Binoc, brought out by Taylor Instrument Cos., Rochester, N. Y. Advantages of the design are said to include: More than twice the accustomed angle of vision, combined with high magnification of the mercury column; binocular vision (i.e., readability with both eyes) at normal or greater than normal distances; triple-lens construction that gathers more light and concentrates it behind the mercury column, making the column stand out in relief; empty-bore reflections are eliminated by the lens angle and extended opaque background. Legibility of these new industrial thermometers is further improved by the bold, black numerals and graduations on the cream-tinted, nontarnishing scale.



Increased angle of vision and high magnification of the mercury column make these thermometers easier to read

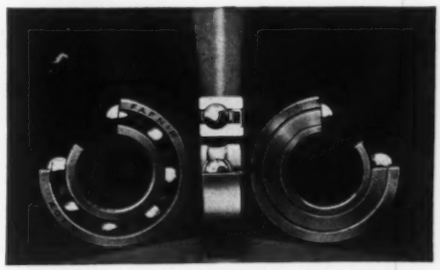
Announces Air-Drying Enamels

ENAMELS of the air-drying type developed especially to aid in preventing the corrosion of iron and steel in railroad, marine, mining, oil

. . . *against power loss and wear*

The extreme, uniform hardness that contributes so greatly to the long life of Fafnir Ball Bearings is achieved by automatically controlled heating and oil quenching carried to refinements far beyond "standard practice." Like many other steps in the manufacture of these bearings the extra care taken proves its worth many months after the bearings have been installed. With Fafnir, extreme accuracy and long life are inherent qualities directly attributable to meticulous attention to detail.

Although all Fafnir Bearings are built to the same high standards there is always one best adapted to a particular duty. Minimizing friction losses, keeping maintenance costs constantly low, the right Fafnir makes possible full utilization of the productive capacity of plant or machine. Fafnir engineers, with more than a quarter century of service behind them, will help you to select this right type . . . The Fafnir Bearing Company, *New Britain, Connecticut,* Atlanta, Chicago, Cleveland, Dallas, Detroit, Kansas City, Los Angeles, New York, Philadelphia.



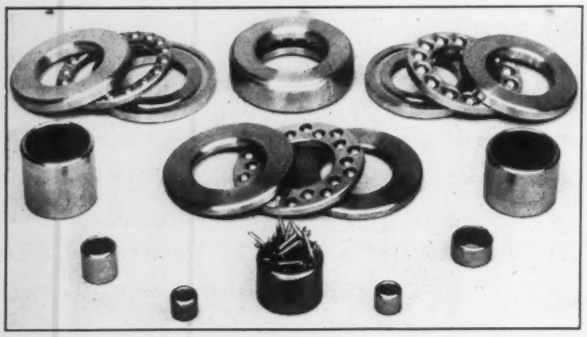
Hardening is one of the 77 operations in the manufacture of a Fafnir Ball Bearing, of which this Felt-Seal Bearing is a representative type.

FAFNIR

B A L L B E A R I N G S

LAMINUM SHIMS not only save in the original precision assembly of bearings . . . they add a selling feature by providing for quick, accurate service adjustments FOR THE LIFE OF THE BEARING! They save precision machining and fitting . . . adjustments are made right at the machine by simply p-e-e-l-i-n-g one or more .002" laminations from the solid shim. Write for a sample of LAMINUM.

LAMINUM
Precision adjustment SHIMS
LAMINATED SHIM CO., 21-26 44TH AVE., LONG ISLAND CITY, N. Y.



800% GREATER DEMAND

THAT'S the way industry has been flocking to Bantam for bearing requirements, whether they be Ball Thrust, Roller Thrust or Journal Rollers. An 800% increase in demand since 1932.

After all, "the proof of the pudding is in the eating," so why not try Bantam Bearings once? From then on your own good judgement will bring you back for more.

Write for NEW Catalog

Every designing engineer in the country should have a copy of this book. It shows a comprehensive picture of the bearings which are saving money for manufacturers of small and large machinery. Send for catalog No. 101 TODAY!

THE BANTAM BALL BEARING CO.
SOUTH BEND, INDIANA

BBB TAKE YOUR TOUGHEST BEARING JOB TO BANTAM

and general industrial service have been announced by Maas & Waldstein Co., Newark, N. J. These new anti-corrosive enamels are made of rust inhibiting pigments and a synthetic resin vehicle, and form a hard, tough coating that is resistant to wear and of pleasing appearance They are said to be particularly effective in providing protection from the corrosive action of humidity, salt water, alkali, and a variety of chemicals, and in preventing electrolytic action. They may be applied by either brush or spray. Available colors are brown, black, red, and a bronze liquid which serves as a vehicle for aluminum and other metallic powders.

Introduces Improved Cap Moldings

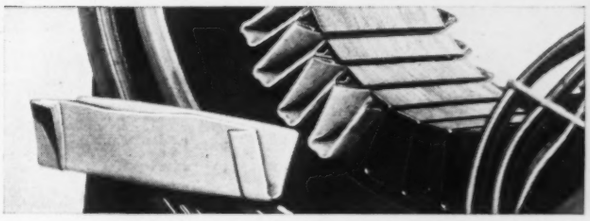
IMPROVED stainless steel cap moldings made for 1/16, ⅛, 3/16 and ¼-inch material are a recent development of Pyramid Metals Co., 455 North Oakley boulevard, Chicago. These moldings can be employed for numerous decorative and protective uses on machinery, lending special decorative effect on many machines when used as corner protection or trim on some other portion of the machine. The moldings are available in a wide variety of styles.

Relays Maintain Synchronism

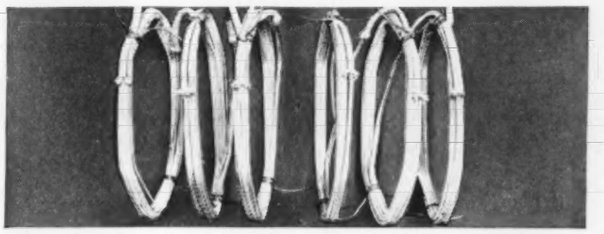
RELAYS designed to prevent continued operation of synchronous machines out of synchronism with their connected system, or to function to separate large interconnected systems at a specific location in the event of an out-of-step or unstable condition between the sources of power on both sides of this location, have been announced by General Electric Co., Schenectady, N. Y. The out-of-step relay consists of an instantaneous overcurrent unit, a single-phase power-directional unit, an auxiliary unit to increase the operating speed, a notching device, and a time-delay element for resetting the notching device. All these are mounted in a standard 5½ by 16-inch universal case. A capacitator and resistor for the notching unit are mounted externally.

The device operates on an overcurrent and power-directional principle. When two synchronous machines, or groups of machines, pull away from each other in phase angle, the current and power interchange increase. When this action proceeds far enough, i.e., approximately 90 degrees between the internal voltages, the overcurrent unit picks up its contacts to energize the armature coil circuit of the polarized

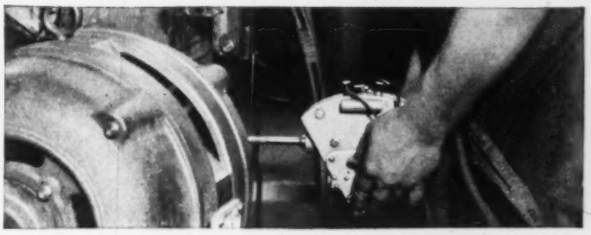
Sealed-in leads. Brought through an opening in the frame—and there anchored permanently with a special sealing compound. The roughest kind of service during installation or afterward cannot put strain on the field connections.



Special cuff insulation. Empire cloth inside of two special preformed fibrous sheets is inserted in the stator core slots. An ingenious method of folding makes a self-locking cuff which gives permanent protection to the coil when it leaves the stator slot.



Group-wound coils. A phase group winding complete in one piece of wire reduces stub connections and eliminates a source of mechanical failure. Lead connections from these phase windings are *welded*, not soldered or brazed—an innovation in winding construction that keeps motors out of the repair shop.



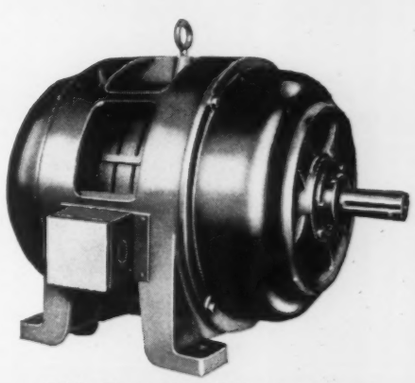
Every motor is given a thorough vibrometer test to make sure of proper dynamic balance. Eliminate vibration and you reduce to a minimum the wear on bearings. Sealed ball bearings and smooth running insure trouble-free service from F-M motors under the severest operating conditions.

It's the little things that make a great motor

Certainly, a motor must come up to *electrical* specifications. But remember, a motor is an apparatus for converting electrical energy into *mechanical power*. And it's in the mechanical design and construction that you will find the biggest difference between one make of motor and another.

Fairbanks-Morse motors meet the most exacting electrical specifications. But with characteristic thoroughness, Fairbanks-Morse has achieved a position of leadership in *mechanical* design and construction of motors.

We illustrate a few of the new, unusual methods which are employed to make Fairbanks-Morse "Type Q" motors give longer, trouble-free service. The complete story of this extra value in motors will be sent on request. Address Department L441, Fairbanks, Morse & Co., 900 South Wabash Avenue, Chicago, Ill. 34 branches at your service throughout the United States.



F-M "Type Q" Ball Bearing Motor

6764EA10.1

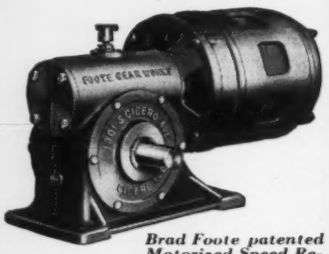
106 YEARS OF PRECISION MANUFACTURING

FAIRBANKS-MORSE *Motors*

POWER, PUMPING AND WEIGHING EQUIPMENT

MOTORIZED REDUCERS WITH 4 SPECIAL FEATURES

EXPLOSION proof motors may be removed from the reducer without disturbing the underwriters label, due to a patented feature in the method of mounting motor on reducer. This feature is used in all sizes and styles. It provides free floating of the motor shaft and eliminates the possibility of oil entering the motor.



Brad Foote patented Motorized Speed Reducer.

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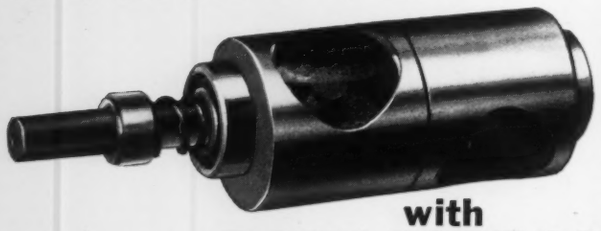
FOOTE GEAR WORKS, INC.

1301-G SOUTH CICERO AVE. CICERO, ILLINOIS

A MULTITUDE of APPLICATIONS



with ROTAPISTON

The reciprocating cylinders at right angles to one another — each double acting—afford continuous flow.

- ¶ Pumping paint pigments to paint grinding machines.
- ¶ Circulating enamel in enamel dipping vats.
- ¶ Circulating quenching oil thru cooling coils.
- ¶ Circulating 600-W lubricant in large speed reducers.
- ¶ Circulating soluble oil coolant on machine tools

3 Standard Sizes, interchangeable with other makes of pumps. 4 other models with special mountings available. Capacities from 1/8 to 324 gallons per minute. *Write for folder.*

THE GLOBE PRODUCTS CO.

4008 E. 89th St. Cleveland, Ohio

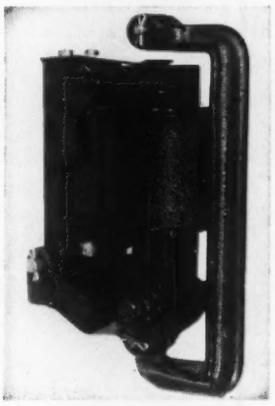
auxiliary unit. As the phase angle continues to increase, the current likewise increases, but the power interchange decreases, and at about 180 degrees between the internal voltages the power reverses. This causes the power directional unit to function and, through the closed contacts of the auxiliary unit, causes the notching device to step up one notch. At 540 degrees the second notch is stepped up, and at 900 degrees the third, causing the main contacts to close in the tripping circuit of the circuit breaker to disconnect the machine. The relay is provided with a target which gives visual indication after operation. The contacts are automatically reset after a time-delay, but the target may be reset manually.

Enamels Are Developed for Zinc

AIR-DRYING lacquer enamels especially designed for finishing zinc and aluminum die castings have been placed on the market by Maas & Waldstein Co., of Newark, N. J. This new enamel, developed after research work directed toward developing an enamel finish that will adhere tenaciously to zinc, will produce a durable elastic finish in one coat. The substance is supplied in gloss and egg-shell sheens, white and black, and 32 standard shades. Special colors can be supplied when desired.

Solenoids Are of Improved Design

ALTERNATING current solenoids of new design in three sizes, the SD-5, SD-10 and SD-15 for 5, 10 and 15 pounds pull respectively, are now being manufactured by C. J. Anderson & Co. Inc., 218 West Austin avenue, Chicago. These units are for a stroke of one inch. The accom-



When solenoid magnet is energized a full magnetic circuit is completed

panying illustration shows the solenoid with the "push-up" yoke. When "pull-down" operation is desired, this yoke is not furnished.

These solenoids are of the full sealing type. When the magnet is energized the movable core strikes the stationary core at two points, completing a full magnetic circuit or field. The overall length of the push-up type is 8-3/16 inches. Overall length of the pull-down type is 6-11/16 inches. Overall widths are 3-3/16, 3-11/16 and 4-3/16 inches for the 5, 10 and 15-pound types respectively. Distance front to back of the push-up types is 4 ¾ inches and on the pull-down types 4 inches.

Cable Resists Deterioration

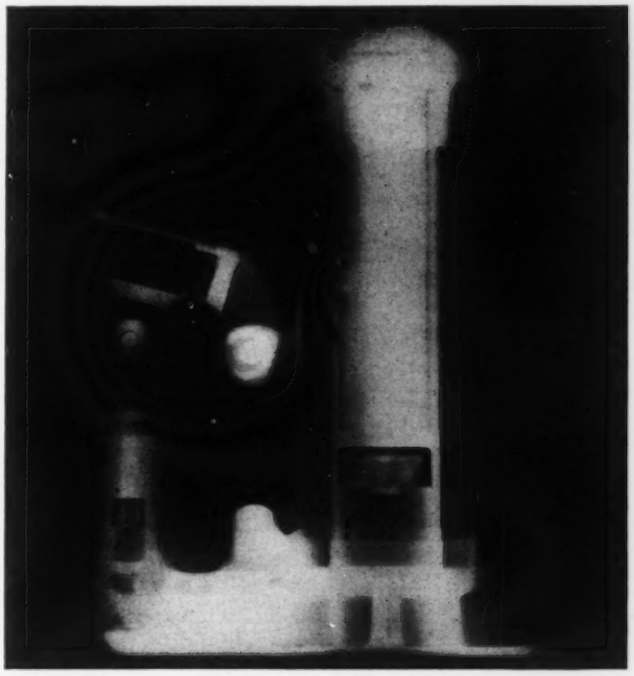
DESIGNED particularly for connection of equipment which may have to be relocated, the new "Powerduct" cable of Anaconda Wire & Cable Co., 25 Broadway, New York, resists deterioration by oil, grease and gasoline and will withstand considerable mechanical abuse including impact without chafing or fraying. Having a smooth exterior, it does not collect dust and presents a neat appearance when suspended in the open. In the construction, three rubber-insulated (600 volts) color-coded conductors and one bare ground conductor are cabled with saturated jute fillers, bound together by presaturated tape. Over this assembly is a heavy protective coat of long-fiber cotton woven like a fire hose—not braided. The outer covering is saturated and finished with moisture resisting and flame retarding compounds. Each conductor consists of seven strands of tinned soft-annealed wire.

Designs V-Belt Couplings

COUPLINGS for V-belts, known as "Grip-Flex", are now being manufactured by Shippert Mfg. Co., 414 South Galena avenue, Dixon, Ill. The new coupling, shown herewith, is made in all standard sizes from A to E, in a variety of types to suit the size and strength of the belts. Features of the construction include anchor plates which completely surround the ends of the belt so that no strength is lost in attaching the coupling; trailer pins to ease the strain of heavy loads and shock; side plates; and replaceable roller bearings.

Size A is attached to the belt by means of a firm metal band that completely surrounds the ends of the belt. Linkage is of the hook type, and the friction pin is of the self-lubricating

X-RAY PICKS OUT
THE PACKING POINT*
WHERE GRATON & KNIGHT CAN HELP THE MACHINE DESIGNER



Lasting, efficient operation of the machine depends on the proper packing—often a difficult, complicated part to design. Designers can save themselves headaches and possible hitches in production, by calling in Graton & Knight packing engineers before it's too late for modifications in design. Our engineers, with X-ray thinking, successful in solving many a knotty problem, are glad to help you out whenever you come up against the Packing Point*. From a hydraulic jack like the one whose X-ray is shown here, to giant mechanisms—we work with you to build the most economical, efficient packing for your machine.

This Designer's Packing Would Have Made His Instrument Useless

An instrument manufacturer, ready to start production on a new measuring device, ordered from us a supply of packings. Fortunately we checked the requirements, found that the packing the manufacturer specified would have kept the device from entering properly, and suggested a new packing design that ensured perfect centering.

Write or wire your Packing Point* problem to Graton & Knight.

* *The point in any design where the choice of the right packing arises.*

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GRATON & KNIGHT COMPANY
357 FRANKLIN STREET
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"Creating Success at the Packing Point"
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MAKING JOINED SHAFTS GET ALONG TOGETHER

. . . . is a function for a really *flexible* coupling. L-R Type "W" just "eats up" shock loads! Visible free floating cushions are handily, quickly interchangeable without tearing down coupling; the drive not being disturbed. *Non-Lubricated.* For big machines, in a class by itself. Bores up to 14 inches.

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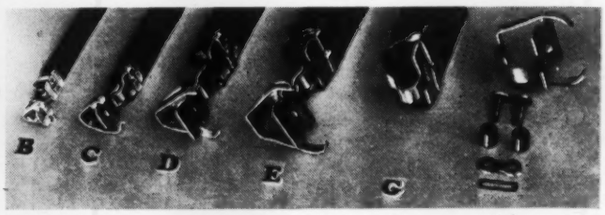
rawhide type of construction. Size B is attached to belt in the same way as size A and is fitted with case hardened bearing for the link pins, housed in a belt and bale of tough steel. The

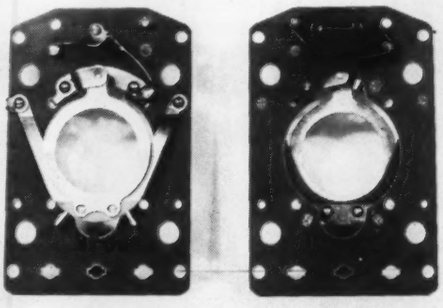


Couplings are designed to simplify the problem of joining V-belts of all sizes

bearing is made larger than the pin, so that the pin may have a rocking action in the bearing. Sizes C, D and E are likewise anchored to the belt with steel plates and in addition have trailers and main coupler parts keyed to the belt ends. Heavy-duty roller bearings which operate without oil are employed in these sizes.

Cutout Switch Protects Motor

A CUTOUT switch which operates in such a way as to cut the motor off the line before it is permanently damaged has been developed by Leland Electric Co., Dayton, O. This switch operates from both the heavy current encountered during starting conditions and from internal motor heat encountered during heavy



This switch cuts an overheated motor off the line before it is permanently damaged

running overloads and provides the motor with inherent overheating protection. In the construction, heat is applied to a fusible alloy by the thermal bar, which is in intimate relation with the motor windings. This bar will pick up heat either radiated or convected, and before the internal heat is sufficiently high to damage the motor windings the fusible alloy will melt and permit rotation of the solder pot and cam

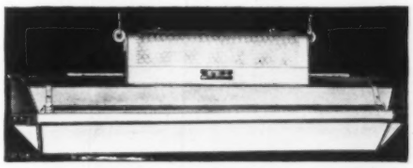
assembly in such a way as to break the contact between the movable spring and the stationary spring shown in the accompanying illustration.

This principle is satisfactory as long as there is not a high differential in heat between the component parts of the motor. In the case of split phase or capacitor motors on their stalled rotor conditions, the heat is generated so fast and absorbed by the cold motor in such a way as to maintain a high differential between the motor windings and the area surrounding the thermal bar. Under these conditions it is necessary to place on the thermal bar a winding of a resistance wire which is connected in series with the starting winding. The fusible alloy in the pot is then melted by the heat furnished by the resistance wire winding and the action is the same as in the foregoing.

Engineering Department Equipment

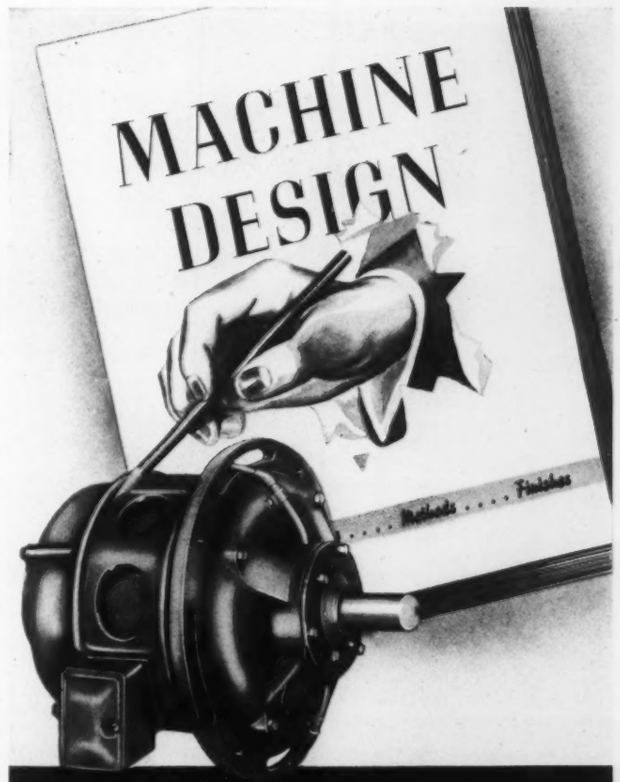
Light Is Color-Corrected

COLOR-CORRECTED light, said to be well adapted to difficult seeing tasks and obtained by combining mercury vapor light and incandescent light in a single unit is a recent development of General Electric Vapor Lamp Co., Hoboken, N. J. In this combination, the blue-green effect characteristic of mercury vapor



Mercury vapor and incandescent light are combined for close work

lamps alone is balanced by the reds and yellows in which incandescent light is rich, producing a daylight effect. The balance is obtained by adding light, thus increasing the efficiency. The mercury vapor light source is a straight 33-inch Cooper-Hewitt tube, 1 inch in diameter, mounted horizontally beneath a newly designed reflector of Alzac aluminum. The incandescent light sources are four 150-watt Mazda lamps, located diagonally in a horizontal plane above the mercury tube. With the light, there is no glaring or blinding effect, even when looking directly into it, and there is no reflected glare. Lights of this type can be adapted to detail drawing work in the design department.



The Designer's
VIEWPOINT

The viewpoint of the machine designer has been very emphatically kept in mind in designing the broad line of Diehl motors. A check of any Diehl motor will quickly reveal this fact. Whether the motor is viewed with an eye to its operating characteristics, mechanical construction, appearance, or adaptability to special requirements, it will be found to conform to modern machine demands.

Diehl motors are standard equipment for machinery of almost every type. They have proved their efficiency and dependability in the air, on land and at sea. Diehl's design and production facilities are highly regarded by manufacturers of motor driven machines.

Utilize our fifty years of motor building experience in working out your problems of motor application.

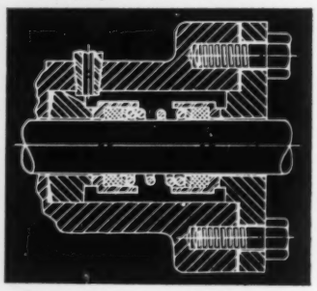
DIEHL MANUFACTURING CO., Elizabethport, N. J.
Electrical Division of THE SINGER MANUFACTURING CO.
ATLANTA BOSTON CHICAGO DALLAS NEW YORK PHILADELPHIA

DIEHL MOTORS

The
BROWNIE
COOLANT PUMP
HIGH CAPACITY - LOW
HORSEPOWER INPUT
OPEN
TYPE
CLOSED
TYPE
Designed to pump lapping compound that would wreck the ordinary pump, these improved models possess a minimum of parts; no packings to leak and no screens to clog.
Shaft-whip-friction has been eliminated by placement of a ball bearing within one inch of impeller permitting self-alignment . . . May we mail description bulletin on the new economical BROWNIE pump?

THE TOMKINS-JOHNSON CO.
JACKSON MICHIGAN

Another Typical Rotary Seal Application



This Rotary Seal arrangement is the one used in many makes of large refrigeration compressors and in rotary pumps of various kinds.

ROTATES WITH THE SHAFT

Write for new bulletin giving general information on the construction, operation and application of Rotary Seals.

ROTARY SEAL COMPANY
GENERAL OFFICES
803 West Madison St. Chicago, Ill.

MEETINGS and EXPOSITIONS

ONE OF the most important meetings of the year is scheduled for the early fall when the American Society for Metals opens its annual Metal Congress and Exposition in Cleveland . . . . Opening in October, the exposition will include displays of the latest developments in materials and machinery . . . . Co-operating with the metals society, separate technical programs are to be offered by the American Society of Mechanical Engineers, American Institute of Mining and Metallurgical Engineers, American Welding society, and Wire association * * * Papers to be presented before the technical sessions of the metals group will include a discussion of cadmium alloys for bearings by C. F. Smart . . . . H. B. Wishart and S. W. Lyon will consider the effect of overload on the fatigue properties of several steels at various low temperatures . . . . Austenitic stainless alloys, their properties and characteristics, will be the topic of V. N. Krivobok and R. A. Lincoln . . . . A. V. deForest will talk on the laws and fundamentals of plastic deformation . . . . and D. K. Crampton has taken as his subject the extrusion of metals * * * Papers to be presented before the mechanical engineers' group will cover the important steps made recently in the welding of machines and machine parts.

In addition to this Congress, the American Society of Mechanical Engineers is planning an earlier meeting to be held at Hotel Niagara, Niagara Falls, N. Y. * * * Technical papers for this meeting include: "The Mechanics of the Car Retarder," by N. C. L. Brown, and "Latest Developments in Aircraft Power Plant Accessories," by S. H. Webster * * * The program, following closely the World Power Conference, will include technical papers and discussions by some of the leading foreign delegates to the Conference.

Sept. 16-19—

American Society of Mechanical Engineers. Technical meeting to be held at Hotel Niagara, Niagara Falls, N. Y. C. E. Davies, 29 West Thirty-ninth street, New York, is secretary of the society.

Sept. 22-25—

Association of Iron and Steel Engineers. Exposition and thirty-second annual meeting to be held at Convention hall, Detroit. Brandt Wiley, 1010 Empire building, Pittsburgh, is secretary.

Sept. 28-Oct. 3—

American Bakers association. Exposition of equipment to

be held at the Auditorium, Atlantic City, N. J. Tom Smith, 1135 Fullerton avenue, Chicago, is secretary.

Oct. 5-10—

Industrial Materials exhibit. Fourth annual exposition to be held at Hotel Roosevelt, New York. Information may be obtained from Don Masson, 247 Park avenue, New York.

Oct. 12-17—

Dairy and Ice Cream Machinery and Supplies association. Annual exposition to be held at the Auditorium, Atlantic City, N. J. Charles W. Caldwell, 232 Madison avenue, New York, is assistant treasurer.

Oct. 15-17—

Society of Automotive Engineers. National Aircraft Production meeting to be held at Ambassador hotel, Los Angeles. John A. C. Warner, 29 West Thirty-ninth street, New York, is secretary.

Oct. 19-23—

National Metal Congress and Exposition. Extensive exhibition and discussion of materials and processes to be held at Public Auditorium, Cleveland. W. H. Eisenman, 7016 Euclid avenue, Cleveland, is managing director.

Oct. 19-23—

American Society of Metals. Annual meeting to be held at Cleveland. W. H. Eisenman, 7016 Euclid avenue, Cleveland, is secretary.

Oct. 19-23—

American Welding society. Annual meeting to be held at Hotel Cleveland, Cleveland. M. M. Kelly, 33 West Thirty-ninth street, New York, is secretary.

Oct. 19-23—

Wire association. Annual meeting to be held at Cleveland. R. E. Brown, 17 East Forty-second street, New York, is secretary.

Oct. 19-24—

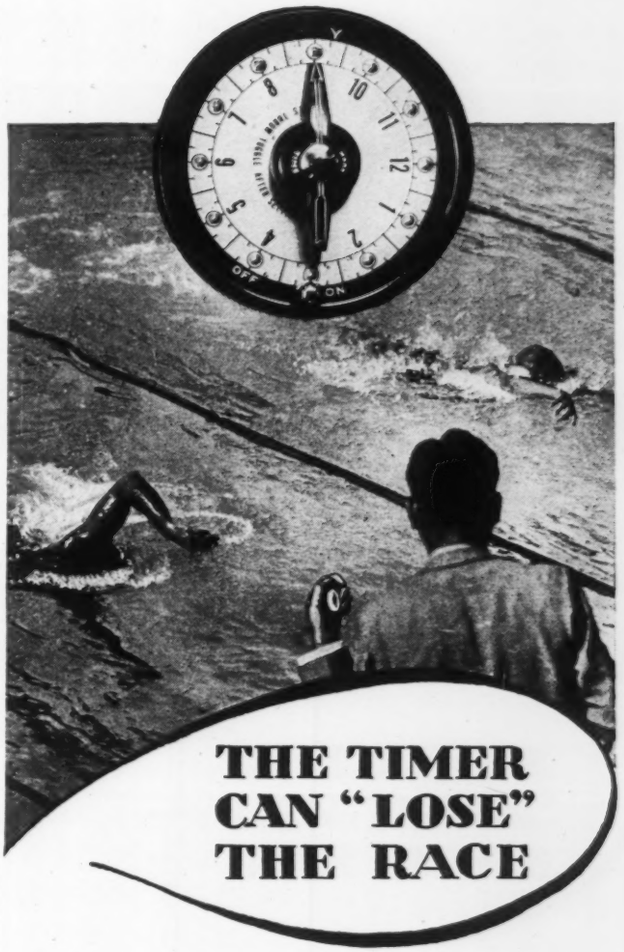
National Business Show. Exhibition of office machinery and equipment to be held at Commerce Hall, Port Authority building, New York. Frank E. Tupper, 50 Church street, New York, is in charge.

Oct. 22-23—

American Society of Mechanical Engineers. Technical meetings of the machine shop practice, iron and steel, process and petroleum divisions to be held in connection with the Metal Congress. C. E. Davies, 29 West Thirty-ninth street, New York, is secretary of the society.

Oct. 26-30—

American Gas association. Annual meeting and exhibition of machinery to be held at the Auditorium, Atlantic City, N. J. Kurwin R. Boyes, 420 Lexington avenue, New York, is secretary.



THE TIMER CAN "LOSE" THE RACE

YOUR product can be helped to win the race for sales against all competition if the timing mechanism is dependable, faithful, simple and fool-proof—in other words, if it is a MARK-TIME Timer. All important developments in time switches have been made by MARK-TIME—the one-gear-train, instead of complicated clock-work mechanism, the sturdier construction, the finer appearance.

Let our engineers make specific recommendations for assembling a MARK-TIME Timer in your product, as they have already done for hundreds of electrical appliance manufacturers.

MARK-TIME Switches are protected by the following patents, also patents pending:

1353850	1934611
1895399	1959645
1951490	2001266
1995363	1895398
1773697	1938721
1929793	1956998
1952893	1916867
1996173	1943839
1795969	1969034

and Foreign Patents.

M. H. RHODES, Inc.
ROCKEFELLER CENTER, N. Y. C.

MARK-TIME *Timers*

THE WORLD'S ONLY EXCLUSIVE SPECIALIST IN TIME SWITCHES

STANDARD EQUIPMENT WITH HUNDREDS OF ELECTRICAL APPLIANCE MANUFACTURERS

HIGH Speed SEAL

Descriptive and dimensional data will be furnished upon request.

Oil is sealed in housing by bronze ring pressing against bearing race or shaft shoulder. Several small compression springs assure evenly distributed pressure.

Gits high speed seals are furnished with fabric or metal diaphragms. Fabric diaphragm seals are to be used where temperatures are constant up to 220° F. The metal should be used on applications where constant temperatures are above 225° F.

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MANUFACTURING CO.
1861 S. KILBOURN AVE., CHICAGO

QUIET, POWERFUL and EFFICIENT
LEIMAN BROS. PATENT ROTARY POSITIVE
AIR PUMPS
USED BY THE WORLD'S LEADERS AS STANDARD EQUIPMENT ON ALL SORTS OF AUTOMATIC MACHINES AND DEVICES

MANY SIZES and STYLES

TAKE UP THEIR OWN WEAR
No packing or tips on the wings

The built-in one-year-lubrication of Leiman Bros. Rotary Positive Air Pumps is the new wool yarn packed bearing which holds in suspension enough lubricating oil for one year's service — strained and purified.

The continuous unbroken cylinder surface makes these always noiseless air and gas pumps doubly quiet. The air enters and emerges in a sidewise course through the bypass in the cylinder head side.

This means a smooth, glassy-like cylinder surface, easy operation and saving in power.

The advantage gained by this simple construction is that the wings in constant operation will wear in conformity with the inner cylinder wall and become smooth and glassy like as well as case hardened in use, and maintain a perfect fit and positive air pressure, even after long continued usage.

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177 (9) Christie St., Newark, N. J.
LEIMAN BROS., N. Y. Corp., 23 (P9) Walker St., New York City
Makers of good machinery for over 45 years

Corrosion Resistance of Metals and Alloys

(*Concluded from Page* 33)

fit to delve more deeply into theory, the book likewise will be of tremendous help. Seventeen of its major chapters are followed by bibliographies which are remarkable for their completeness. For instance, that covering Iron and Steel lists 134 references, Chromium Alloys has 106, Aluminum and Its Alloys has 104, and Zinc, 57.

The book is built upon "The Arch of Corrosion Knowledge" shown graphically in the head on page 33, in a cut reproduced from the introductory page. There are two divisions, the first and lesser being headed General and Theoretical, the second headed Corrosion Behavior of Specific Metal and Alloy Groups. Chapters in Part I are devoted to: Rate Factors; Forms of Corrosion; Corrosives; and Metal Corrosion Properties.

Chapters included in Part II cover: Magnesium and Its Alloys; Aluminum and Its Alloys; Zinc and Zinc Coatings; Cadmium Plate; Tin and Tin Plate; Lead; Iron and Steel; Silicon-Iron; Molybdenum Alloys; Chromium Alloys; Chromium Plate; Nickel-Iron Alloys; Nickel; Nickel-Copper Alloys; Copper; and High Copper Alloys — Brass, Bronze, Nickel Silver. There are complete and usable indexes, one of general contents by chapters, another of authors and a third of subjects. This skilful job of indexing deserves special mention by reason of the fact that it has a great deal to do with putting this book into that classification called "ready reference" volumes.

Tables and Graphs Supplement Text

Supplementing the text are a great number of useful formulas, tables, charts, graphs and illustrations. Not only is the designer warned what not to use under specific conditions but also he is advised exactly what to use and how to use it to overcome the troubles against which he is forewarned. In the estimation of this reviewer, who in years gone by was many times "stumped" by problems which this book would have solved in short order, it is a volume which deserves a place right beside the mechanical and electrical engineering handbooks which machine designers invariably keep within easy reach on their work tables. Incidentally, it ties in neatly with the *Directory of Materials Used in Design of Machines* which is published from time to time as a supplement to MACHINE DESIGN, the most recent being in March 1936.

Corrosion Resistance of Metals and Alloys, published by Reinhold Publishing Corp., is available through MACHINE DESIGN for $7 plus 15 cents postage.

Every Patent Action Needs Individual Study

(*Concluded from Page* 41)

models, with sufficient proof of identity in point of time, for otherwise such a facile means of establishing priority of invention would in many cases offer great temptations to perjury and would have the effect of virtually precluding the adverse party from the possibility of rebutting such evidence." A case involving the foregoing principle of law was had with reference to the two machines shown in *Figs.* 4 and 5. The inventor of *Fig.* 4, filed his patent application on December 23, 1890. The inventor of *Fig.* 5 filed on September 14, 1892, and attempted to show that he conceived the invention before the other inventor But the difficulty was that he did not make sufficient drawings to overcome the burden of proof and the award was given to the inventor first to file. This shows the importance of keeping proper records and drawings of all inventions.

Example VII

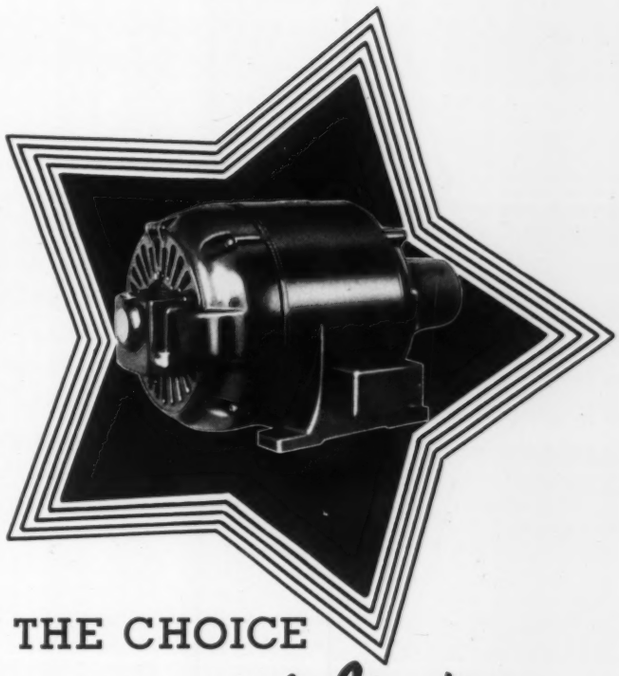
Manufacturer's letter One of the men in our company has made an invention and no one can tell for sure how it works. We have discussed the principle of operation of this new device with several outstanding engineers and they are unable to tell us the exact principle of operation, and no two agree.

I am wondering what we can do about getting a patent when no one can tell how the machine works.

Patent Attorney's letter *The law is fairly well established that an inventor does not have to understand the scientific principles by which his device operates, so long as he explains how the device is constructed and how to operate it.*

In the event that a theory is advanced in a patent application for such device, it is well for the application to state that the inventor does not want to be limited to the consequences of a theory. Note the language used in the patent application for the copper-oxide rectifier having one enlarged plate shown in *Fig.* 2. It reads as follows:

"While I do not wish to be limited to the consequences of a theory, it is my belief that the paraffin fills numerous small cracks, and perforations, which otherwise would exist in the oxidized layer and thereby prevent the graphite from filling such cracks and making contact with the underlying mother copper, thereby partially short-circuiting the oxidized layer which is the effecting agent in producing the uni-lateral conductivity above described."



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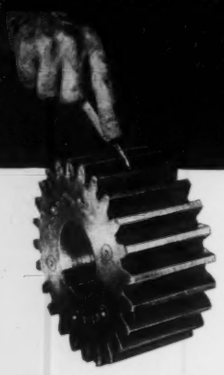
• Those manufacturers who want a motor that is a little different – a little more precisely made – a little better looking are turning more and more to Peerless as their motor supply.

Another thing – Peerless motors cost no more, but Peerless buyers get a great deal more. Our manufacturing facilities are large and modern. We are big enough to take care of all requirements – small enough to value all of our business highly and to give it our closest personal attention. Ask us to prove how we can be of real service to you.

The Peerless
ELECTRIC COMPANY
WARREN • OHIO

The Gears that Insure *both* Strength and Silence!



WALDRON *Laminated* SILENT STEEL *Gears*

No other gear gives *all* their advantages!

The laminated construction eliminates noise.

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With a tooth profile not subject to deformation, wear is reduced and service life increased. Compared from any angle with non-metallic gears, the Waldron Silent Steel Gears prove much more efficient and economical to use on drives.

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MANUFACTURERS' PUBLICATIONS

ALLOYS (STEEL)—Complete details on manganese steel including chemical content, physical properties, method of manufacture, heat treatment, fabrication and machining, and applications are given in an interesting folder of American Manganese Steel Co., Chicago Heights, Ill.

ALLOYS (STEEL)—A new booklet designed to simplify the alloy steel selection problem as far as possible and still cover the complete requirements of the small buyer has been prepared by Carpenter Steel Co., 120 West Bern street, Reading, Pa., entitled "Alloy Steel Simplified." With the booklet it will be possible to choose the exact steel needed for a specific service. The properties of the steels are so presented that an engineer can quickly determine the steel to specify should a compromise among several desirable qualities be necessary. Another interesting publication of the company gives working data and technical facts on stainless steel in the form of a file folder. In addition to including complete working data and physical properties of the steels, this publication divides available steels into three groupings and indicates the workability and properties of these groupings in a comparative fashion to enable exact selection.

BERYLLIUM—Heat treated castings as made from beryllium-copper are described in a recent publication of Beryllium Corp. of Penna., Reading, Pa. The bulletin gives the properties and characteristics of the alloys available, advantages of the cast parts, and similar data.

CONTROLLERS—A complete line of alternating current, preset-speed controllers for controlling wound rotor motors driving a number of types of printing and embossing equipment is presented in folder GEA-962C of General Electric Co., Schenectady, N. Y.

CONTROLS (ELECTRICAL)—Manual motor-starting switches of the full voltage type for both alternating and direct current are completely described in bulletin GEA-1522C of General Electric Co., Schenectady, N. Y. The bulletin gives all details of the construction and operation of the switches.

CONTROLS (ELECTRICAL)—Electrical Division, Colt's Patent Fire Arms Mfg. Co., Hartford, Conn., is distributing a most complete catalog, No. 59, on its line of Colt-Noark switches and other electrical equipment. This 100th anniversary catalog covers motor starting switches and equipment of many types, motor reversing switches, automatic transfer switches, pushbutton stations, weatherproof and explosion proof contactors, safety switches, and many other types of electrical control equipment.

COUPLINGS—Application data on flexible couplings is included in a most complete bulletin prepared by American

Flexible Coupling Co., Erie, Pa. The bulletin illustrates and describes all of the couplings in the company's line.

COUPLINGS—Diamond Chain & Mfg. Co., Indianapolis, has prepared bulletin 12 which describes and illustrates the company's improved flexible coupling line and explains the advantages in the use of double-strand chain. Many illustrations of installations are included as well as capacity ratings, dimensions, and other data necessary for proper selection.

DESIGN DEPARTMENT—Instruments for use in the design laboratory, such as spectrometers, spectroscopes, spectrographs, polariscopes, interferometers, light sources, and accessories are covered in catalog L-2 of Gaertner Scientific Corp., 1201 Wrightwood avenue, Chicago.

DRIVES—Roller bearing heavy duty couplings for V-belts are presented in a new publication of Shippert Mfg. Co., Dixon, Ill.

DRIVES—Boston Gear Works Inc., Hancock and Hayward streets, North Quincy, Mass., is distributing a booklet which completely lists its line of motorized speed reducers as available from stock, Complete specifications are included.

DRIVES—B. F. Goodrich Co., Akron. has prepared a new 27-page illustrated catalog which gives a complete description of its line of fractional horsepower V-belts and their application. Tables, occupying ten pages, give the center distances corresponding to every standard belt for various speed ratios, motor speeds and pulley diameters. These tables considerably simplify the selection of a V-belt for application to machinery.

FILTERS—Oil filters which can be employed as an integral part of the machine are included in the catalog on oiling devices recently published by Wm. W. Nugent & Co., 412 Hermitage avenue, Chicago.

FILTERS—The new Purolator filter especially designed for machine tools and similar machines is described in a recent bulletin of Motor Improvements Inc., 365 Frelinghuysen, Newark, N. J. Complete details on this filter and how it can be included as an integral part of the design are given, as well as the operating principle of the unit.

FINISHES—Roxalin Flexible Lacquer Co., Elizabeth, N. J., has prepared a unique presentation on its line of flexible finish materials. The bulletins in this presentation contain descriptions of Blax and Leaflex aluminum, both one-coat, air-dry, no-primer finish materials; also Ba-Flex, a flexible enamel that withstands a chromium plating solution; and Blue Knight taupe, a coating that is neutral in color and corresponds to an oxidized electro-plated finish so that it does not show dust, finger marks or metal imperfections.

FLANGES—Kropp Forge Co., Chicago, has issued a new 24-page list of stock flanges which includes dimensions, weights and other pertinent engineering data on standard flange facings, drilling templates, pressure-temperature ratings, threading standards, bursting pressures, and details on standard, extra heavy, and double extra heavy pipe.

LIGHTS—The new lighting handbook of Westinghouse

Bodine Motor

● The Ciné-Kodak Special was developed to provide a versatile 16 mm motion picture camera for the more serious worker. Where it was to be operated for long periods, an electric motor drive was required. This motor had to provide accurate speed control. It had to be silent and operate without vibration. Above all, it had to be reliable.

For these special requirements, Bodine engineers "tailored" a special Bodine motor with a special worm drive, a special speed control, and a special auxiliary winding. Its performance proved gratifying. For years Bodine engineers have been developing fractional horsepower motors for just such special applications. They will be glad to help you solve your motor problem. Write, Bodine Electric Co., 2258 W. Ohio St., Chicago.

BODINE
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FRACTIONAL H. P.
MOTORS
ENGINEERED FOR YOUR PRODUCT

RIGHT ANGLE

SPIRAL BEVEL
CONTINUOUS-TOOTH
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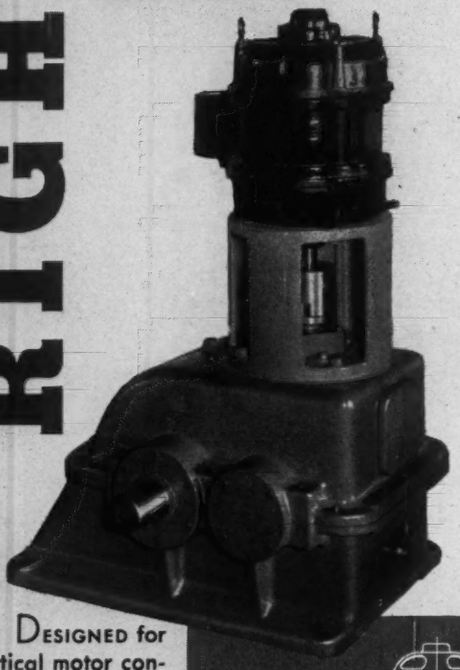

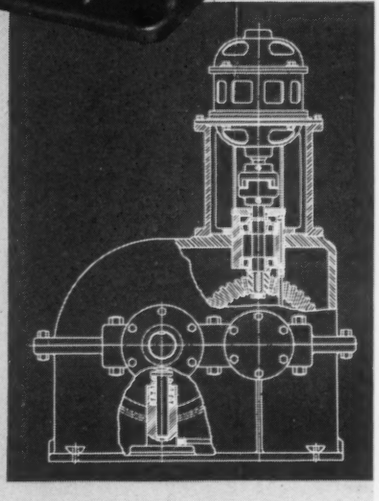

DESIGNED for vertical motor connection and where a limited space is afforded. Streamlined housings, free from complicated pockets and cores. Oil and dirt-proof. Heat-treated Spiral Bevel Gears and Pinions, with Sykes Continuous-tooth Herringbone Gears and mounted on Timken bearings. With a ratio of 6 to 1 up to 45 to 1.

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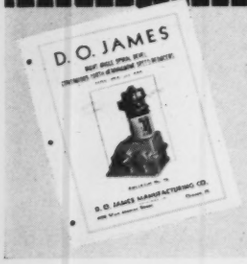
MAKERS OF EVERY TYPE OF SPEED REDUCER AND CUT GEAR



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1114 West Monroe Street, Chicago, Ill.

Send Bulletin No. 16, showing complete engineering data and construction of your Right Angle Spiral Bevel Continuous-tooth Herringbone Gear Speed Reducers.

Name _____

Street _____

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Lamp Co., Bloomfield, N. J., elaborates on specialized fields of lighting, including a mass of detailed information. The design of built-in lighting is especially considered. As the handbook is a handy reference by which engineers can quickly put their fingers on illumination facts, tables are used profusely with the text. Cost of the handbook is ten cents.

MOLDINGS—Snap-on stainless steel moldings which can be used as decorative and protective strips on many types of machinery and which are available in a number of different types are covered in a new booklet of Pyramid Metals Co., 455 North Oakley boulevard, Chicago.

MOTORS—Lincoln Electric Co., Cleveland, has published a folder on its totally-enclosed fan-cooled motors of the squirrel cage induction type. The bulletin gives the characteristics of the motors and shows typical applications.

MOTORS—General Electric Co., Schenectady, N. Y., has prepared bulletin GEA-1974 on its line of fractional horsepower, general purpose, squirrel cage induction motors. These motors are available in 1/6 to ¾ horsepower; 110, 220, 440 and 550 volts; 2 or 3 phase; in all commercial frequencies.

PACKING GLANDS AND PACKING—All types of unit oil seals for inclusion in the design of machinery, and drawings of typical applications are included in the new bulletin on these packings prepared by National Motor Bearing Co. Inc., 1199 Seventy-eighth avenue, Oakland, Calif. Seals as illustrated can be used for a wide variety of services.

PLASTICS—General Plastics Inc., North Tonawanda, N. Y., is distributing an attractive and interesting 12-page booklet on its resins—powders, solutions and colloids. The booklet gives complete details on the materials, specific uses as an aid in selecting the right material for a specific service, applications and characteristics.

PLASTICS—A detailed description of Bakelite molded materials, its many characteristics, properties and applications is included in the seventh edition of the 48-page booklet published by Bakelite Corp., 247 Park avenue, New York. Tables give specific data on physical, mechanical and electrical properties of various types of molding materials.

TUBING—Carpenter Steel Co., welded alloy tube division, 347 Madison avenue, New York, has published a file folder which gives complete details on its line of welded stainless tubing, forms of welded tube products, methods of joining the tubing, notes on corrosion, properties of the tubing, and working instructions.

Research Publications

Strength and Elastic Properties of Cast Iron, by W. J. Schlick and Bernard A. Moore. It has long been recognized that the ordinary flexual (modulus of rupture) formula

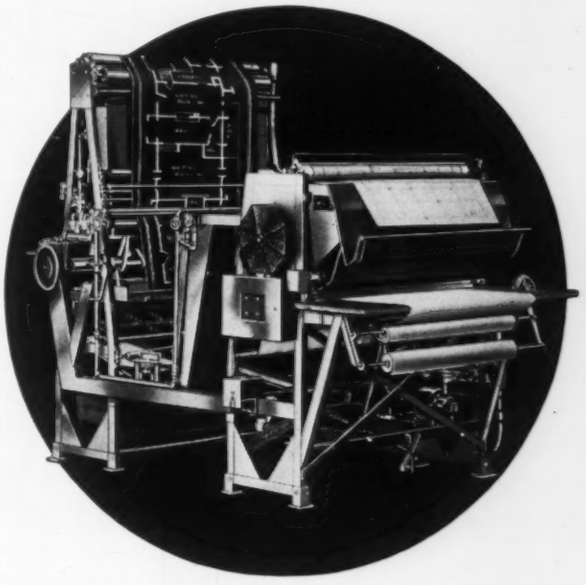
Mc/I does not give the true stresses at failure for any of the ordinary structural materials, and that for certain materials, such as cast iron or concrete, it does not apply exactly at any load. The experimental work included tests of specimens of four grades of cast iron (three thicknesses for each grade) while under: Combined tension and flexure, the tension being about 30, 60 and 80 per cent of the ultimate for each grade and thickness as shown by direct tension tests; plain flexure; direct tension; and direct compression. These tests included determinations of strengths, deformations or deflections, and hardness. Similar tests were made of a supplemental series of specimens which were prepared from the thick plates of one grade of iron by machining off the cast faces so as to produce specimens of three thicknesses. A complete analysis of the experimental data is given. Published as bulletin 127 by Iowa Engineering Experiment Station, Iowa State College, Ames, Ia. 95 pp.

Handbook on Design of Metal Parts for Porcelain Enameling. This publication presents authentic, practical information as to the basic requirements for the proper designing of pressed steel shapes to be porcelain enameled. Faulty design, necessitating reworking beyond the normal number of operations, results in residual strains and excessive thickness of coating in attempts to overcome enamel defects fundamentally due to incorrect design. The booklet discusses the proper gauge of metal, the importance of correct fabrication and design, use of offsets—embosses for strengthening effect, working of the steel, holes and their treatment, brushing as an aid to design, attachment devices and holes, assembly hints, and refrigerator liner design. Drawings indicate correct and incorrect methods of designing many parts. Published by Technical Research section, Porcelain Enamel Institute Inc., 612 North Michigan avenue, Chicago, 15 pp. 10 cents.

Copper Wire Tables. Tables in the terms of international standard values for electrical resistivity, temperature coefficient and density of copper, adopted in 1913 by the International Electrotechnical commission, are presented in this new publication which gives considerable attention to the subject of wire gages. The data are duplicated in English and metric units. Appendices include other data of interest to the engineer employing copper wire. Published as Circular C31 by National Bureau of Standards. Available through Superintendent of Documents, Government Printing office, Washington. 20 cents.

A Study of Torque and Its Influencing Factors as Related to Commercial Tapping of Metals, by Harry L. Daasch and John Hug. Torque requirements were determined for the tapping of each of three metals under conditions simulating shop practice, and an evaluation was made of the influence of torque of four variable factors: Material tapped, depth of thread cut, tap speed, and cutting fluid. Extensive preliminary tests showed that the effects of many variations in individual tap design and manufacture are largely compensating. Torque requirements in tapping steel tended to increase exponentially with the rate of increase of the depth of thread, particularly at high percentages, but in cast iron and brass the increase was almost linear. Published as bulletin 123 by Iowa Engineering Experiment Station, Iowa State College, Ames, Ia. 52 pp.

Cut Your Blue Printing Costs With This Amazing New Machine!



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Business and Sales Briefs . . . . . .

EMERSON ELECTRIC MFG. CO., St. Louis, has announced the following appointments and changes in sales personnel: R. E. Otto, formerly assistant manager of motor sales, is now manager of motor sales; O. D. Metz, formerly manager of the New York office, is assistant manager of motor sales; Val J. Maurer, formerly on the sales staff of the New York office has been named manager of the office; and E. E. Harwood, formerly on the staff of Commercial Engineering division at St. Louis, has been named to the motor sales staff of the New York office.

* * *

The San Francisco office of Lincoln Electric Co., Cleveland, has been moved to 866 Folsom street, where fifty per cent greater floor space is available. Personnel of this office, under the management of L. P. Henderson, is S. H. Taylor Jr., Ed. Weil, W. F. Fischer, E. B. Arrowsmith and R. D. Keener.

* * *

Stearns Magnetic Mfg. Co. has begun the building of an extension to its present plant at 635 South Twenty-eighth street, Milwaukee. The additional space afforded by this new building will provide almost double the capacity of the organization.

* * *

R. B. Nichols has been appointed manager of the industrial bearing division of Bantam Ball Bearing Co., South Bend, Ind. Mr. Nichols has been identified with the bearing industry for over twelve years, having been factory superintendent at South Bend for four years, and manager of the Chicago office for the past eight years.

* * *

Lincoln Electric Co. Cleveland, has completed negotiations for representation in the United States for the Messer Co., Frankfort on Main, Germany, designers and patentees of a low-priced automatic oxygen producing machine.

* * *

Hoyle Jones has been appointed by Republic Steel Corp., Cleveland, as district sales manager in Tulsa, Okla., to fill the vacancy caused by the recent death of C. S. Powers, former district manager.

* * *

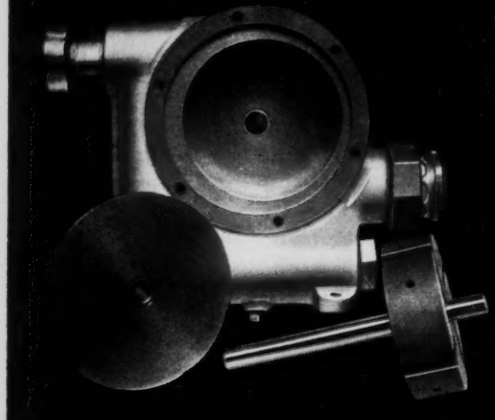
Parker-Kalon Corp., 200 Varick street, New York, has completed a new research and laboratory division for scientifically controlling the quality of its various screw machine products.

* * *

Peter M. Lorenz has been appointed by Inland Steel Co., Chicago, as district sales manager of the St. Louis office. Frederick A. Ernst has been designated as assistant manager. Mr. Lorenz has represented the Inland company in the Detroit and Chicago sales offices.

* * *

C. W. Robinson, formerly of the Chicago office of Armstrong Cork Products Co., Lancaster, Pa., has been appointed manager of the St. Louis office of the company. E. S. Penn, formerly of the Pittsburgh office of the company is now in charge of the Albany, N. Y., office. R. H.



Typical of the many unusual and difficult problems engineers have overcome by using INSUROK was that of obtaining suitable drive-shaft bearings for the rotary pump of the new computing gasoline dispenser manufactured by American Pumps, Inc., of Cincinnati. No lubrication was possible . . . the pump must run dry. After exhaustive tests INSUROK Grade CG was chosen as the superior material for the purpose.

Improve your Product with

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the Superior Laminated or Molded Phenolic

THERE is scarcely a business today in which plastics are not employed in the manufactured product itself or in the production processes, for these new materials offer so many advantages and opportunities for sharp economies that their use has become almost universal. Outstanding among plastics is INSUROK, the superior molded or laminated phenolic that gives unlimited expression to the skill and artistry of the designer.

Richardson Technical Service

embraces the facilities of Design, Research and Engineering laboratories, staffed by men whose sole interest is plastics. Using this service entails no obligation.

A brochure of INSUROK will be sent to those interested.

The RICHARDSON COMPANY

Melrose Park, (Chicago) Ill. Founded 1858 Lockland, (Cincinnati) Ohio
New Brunswick, N. J. Indianapolis, Ind.
Detroit Office: 4-252 G. M. Building, Phone Madison 9386
New York Office: 75 West Street, Phone Whitehall 4-4487

Craig, formerly of the main office at Lancaster, has been transferred to the Louisville, Ky., office. Fred M. Ritts has been appointed manager of the high temperature insulation department of the Armstrong company in its Lancaster office.

* * *

Groov-Pin Corp., Long Island City, N. Y., has moved its offices and factory to new and larger quarters at 411-413 Kerrigan avenue, Union City, N. J.

* * *

J. Harry Christman, vice president of Milcor Steel Co., Milwaukee, has been appointed manager of the company's Chicago office. Earl L. Tanner, vice president, has been appointed general sales manager with headquarters at Milwaukee.

* * *

J. L. Vergilio Co., 942 Prospect avenue, Cleveland, has been appointed sales agent for Northern Ohio by the Ohio Electric Mfg. Co., Cleveland, manufacturer of fractional horsepower motors. J. L. Vergilio and D. S. Cole will handle the application and sales of the motors.

* * *

Bert L. Wood, formerly New York manager of sales for Kalman Steel Corp., subsidiary of Bethlehem Steel Co., has joined the sales force of Carnegie-Illinois Steel Corp. in the New York district office.

* * *

Business of Unyte Corp. and Plaskon Co. Inc. has been merged, with headquarters of the expanded company, to be known as Plaskon Co. Inc., at Toledo, O. The new organization takes over all processes and patent rights formerly held by Unyte Corp. James L. Rodgers Jr. is president. W. P. Pickhardt, former president of Unyte, will be a director of the new company. The New York office of Unyte has been transferred to 41 East Forty-second street. For the present, Unyte will be manufactured and sold under its own name.

* * *

Following reorganization, Erie Malleable Iron Co., Erie, Pa., has named the following officers: Enoch C. Filer, president, Charles G. Strickland, vice president; J. H. Redhead, executive vice president and general manager; and Ray H. Eisenlord, secretary and treasurer. Benjamin H. Scott is general sales manager. Mr. Redhead continues actively in charge as president and treasurer of Lake City Malleable Co., Cleveland.

* * *

Medart Co., St. Louis, manufacturer of mechanical power transmission equipment, has appointed George S. Denithorne as sales representative in the Philadelphia area with offices located at 1224 Commercial Trust building, Philadelphia. James W. Anderson of Dallas, Texas, has been transferred to Chicago by the company where a district office will be opened. Walter G. Kessling of the home office has been transferred to the Dallas office.

* * *

American Rolling Mill Co., Middletown, O., has appointed five new distributors of Armco Ingot Iron and stainless steels. The Edgcomb Steel Co., Philadelphia, and Edgcomb Steel Corp., Newark, N. J., have been named distributors of stainless steels. Those recently appointed to distribute ingot iron are: Syracuse Supply Co., Syracuse, N. Y.; Alamo Iron Works, Brownville and Corpus Christi, Texas; Klauer Mfg. Co., Dubuque, Ia.; and Central Steel & Wire Co., Chicago.

Motors must be diversified to fit the varying requirements of machinery manufacturers and users. Misfits are costly. That's why the Wagner line includes all types of small motors generally applied to motor-driven machinery, making it possible for you to obtain the motor exactly suited for your job.

The Wagner line is so varied that special designing is oftentimes unnecessary except in very exceptional and rare occasions. Whether alternating or direct current; single or polyphase; open, drip-proof, totally-enclosed, or explosion-proof; rigid or resilient-mounted, flange-mounted or built-in; sleeve or ball-bearing; horizontal or vertical—there's a Wagner motor now in existence, ready to be applied to the job.

Wagner motors are chosen by the leading manufacturers because of their well-balanced design, dependability, excellent performance, and their long-life qualities.

Write for complete details of the various types of Wagner small motors. Ask for Bulletin 177.

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